The Federal Plan for Meteorological Services And Supporting Research

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The Federal Plan for Meteorological Services And Supporting Research

FEDERAL COORDINATOR FOR
METEOROLOGICAL SERVICES
AND SUPPORTING RESEARCH

FISCAL YEAR 1976

APRIL 1975
WASHINGTON, D.C.

U. S. Depository Copy

PREFACE

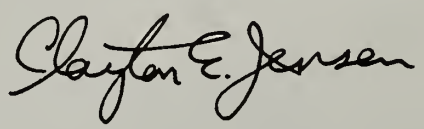
This is the eleventh Federal Plan in an annual series developed by the Federal Coordinator for Meteorological Services and Supporting Research in response to Section 304 of Public Law 87-843. The document provides the Congress and the Executive Branch with an overall coordinated plan for Federal meteorological services and for those research programs whose immediate objective is to improve services. The Plan describes the meteorological programs designed to reduce the economic and social impact of natural disasters, promote the Nation's welfare and economy, preserve and enhance the environment and strengthen the national security.

The introductory section to this Plan presents a review of the progress and some of the more noteworthy accomplishments that have been made since the first Plan was published for FY 1966. An overview is given of the Federal expenditures over the past decade along with the improvements in the national forecast and warning system resulting from these expenditures. This system includes monitoring of the atmosphere, preparing forecasts and warnings, and disseminating forecasts and warnings in a rapid and efficient manner.

Fiscal data for FY 1975 and FY 1976 are summarized briefly following the introductory section. The Basic and Specialized Meteorological Services and supporting research including changes to the FY 1975 programs and plans for FY 1976 are described in the next section. The fourth major section of the Plan discusses meteorological services in functional terms, i.e., observations, analyses and forecasts, communications, dissemination, and general agency support.

The final section describes the meteorological satellite program and includes a discussion of the national operational environmental satellite system and the research activities in support of that system. The last page of this Plan lists the publications prepared, or in the process of preparation, by the Federal Coordinator.

Meteorological activities and the preparation of the Federal Plan are coordinated through the interagency committees shown on the inside front cover. These committees and their subcommittees conduct systematic, continuous reviews of basic and specialized meteorological requirements, services, and supporting research according to the guidelines set forth in the Office of Management and Budget Circular A-62.



Clayton E. Jensen
Federal Coordinator for
Meteorological Services and
Supporting Research

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A Review of Federal Meteorological Programs for Fiscal Years 1965-1976

INTRODUCTION

On November 13, 1963, the Bureau of the Budget (now the Office of Management and Budget) issued Circular A-62 in response to Section 304 of Public Law 87-843. Among other things, this Circular directed the Department of Commerce, with the advice and assistance of other agencies concerned, to prepare and keep current a Plan, and obtain periodic information on its implementation for the efficient utilization of Federal meteorological services and supporting research. An annual *Federal Plan for Meteorological Services and Supporting Research* has been published beginning with the fiscal year budget of 1966. Over the years, this document has provided the Congress with a single source for reviewing the overall Federal program in meteorological services and supporting research.

The Interdepartmental Committee for Atmospheric Sciences (ICAS) is one of a number of standing committees established in 1959 in support of the Federal Council for Science and Technology. The ICAS publishes annually a *National Atmospheric Sciences Program* report that is intended to inform the executive and legislative branches of the government of the total Federal budget devoted to the conduct of on-going and planned research in the atmospheric sciences.

Basic research in meteorology, including weather modification research, is treated in detail in the annual ICAS reports. The United States supports international cooperation in meteorology and participates in the World Weather Program. These programs are treated in the annual *World Weather Program Plan* submitted to the Congress by the President in accordance with Senate Concurrent Resolution 67.

It seems worthwhile at this time to pause and to assess the progress that has been achieved over the past decade. This review will focus on meteorological services and supporting research programs.

To meet national objectives, the Federal government provides two types of meteorological services--Basic and Specialized. The Basic Meteorological Service meets public needs, fulfills requirements common to two or more agencies, and provides the foundation for disaster warnings and the Specialized Services. The Specialized Meteorological Services provide facilities, products, and distribution mechanisms to serve such specialized users as aviation, marine, space operations, agriculture, general military, and air pollution.

Research is categorized as being either basic research or supporting research. Basic research provides the fundamental knowledge and understanding for long-term benefits to service programs. Supporting research is more directly aimed in the relatively short term at improving Basic and Specialized Meteorological Services.

Federal agencies engaged in meteorological programs are the Departments of Agriculture, Commerce, Defense, Interior, State, and Transportation, the Energy Research and Development Administration, Environmental Protection Agency, National Aeronautics and Space Administration, and National Science Foundation.

OVERVIEW OF FEDERAL SPENDING

During this past decade, Federal expenditures for meteorology more than doubled, increasing from a total of $327,543,000 in fiscal year 1965 to $732,247,000 in fiscal year 1975 and to a projected $781,697,000 for fiscal year 1976. Figure 1 depicts

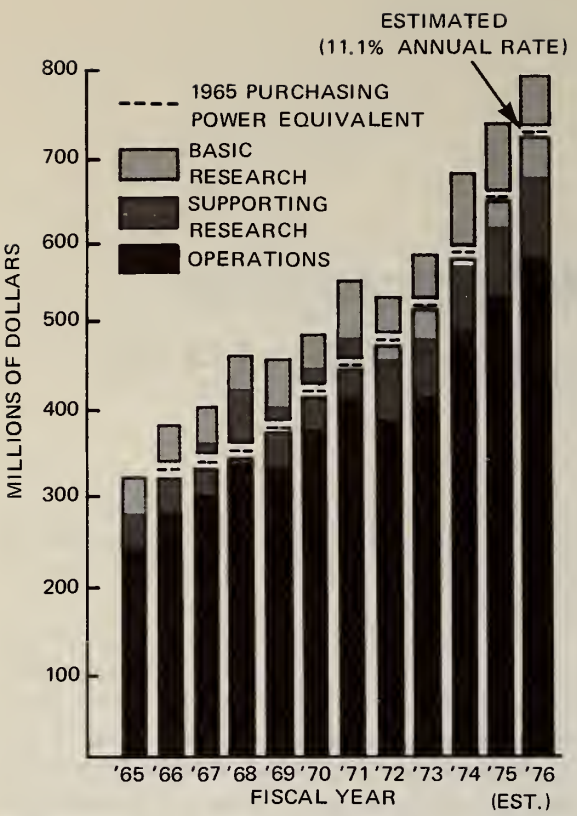


Figure 1.—Federal expenditures for meteorology, fiscal years 1965-1976.

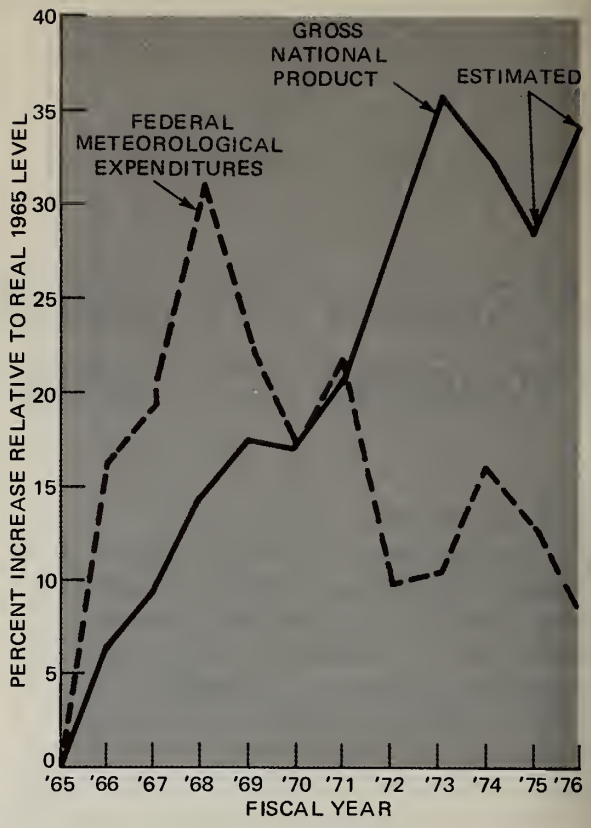


Figure 3.—Percentage increase of annual Federal meteorological expenditures and Gross National Product for fiscal year 1965-1976 relative to real fiscal year 1965 level.

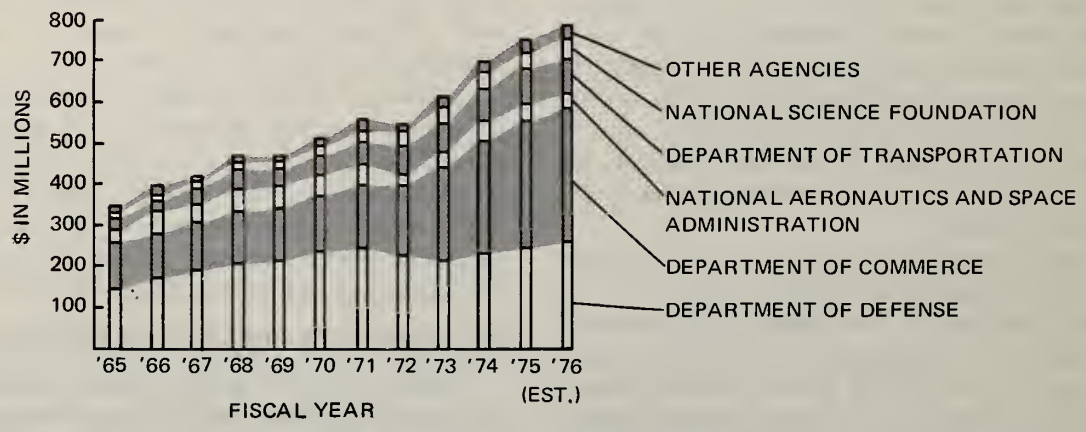


Figure 2.—Federal meteorological expenditures, by agency, fiscal years 1965-1976 (other agencies include the Departments of Agriculture and Interior, Energy Research and Development Administration, and the Environmental Protection Agency.

these funding levels breaking out the costs for operations, supporting research and basic research over the past decade. From fiscal year 1965 to fiscal year 1975, expenditures for operations increased about 124 percent to $525,310,000 (fiscal year 1976 projection--$574,754,000), for supporting research about 85 percent to $86,492,000 (fiscal year 1976 projection--$87,398,000), and for basic research about 185 percent to $120,445,000 (fiscal year 1976 projection--$119,545,000). Figure 2 shows these same total expenditures partitioned in accordance with the responsible Federal agencies. During this same period, a steadily mounting inflation eroded much of the annual increases. To determine the rate of inflation, the Gross National Product Implicit Price Deflator for the purchase of goods and services by the Federal Government as listed in the *Statistical Abstract of the United States 1973* was used. The dashed lines in Figure 1 illustrate over the years the rising disparity in purchasing power because of inflation using fiscal year 1965 as a base.

Figure 3 illustrates the real annual percentage changes in expenditures in meteorology relative to fiscal year 1965. As was shown in Figure 1, it is possible through use of the Implicit Price Deflator to project actual 1965 meteorological expenditures into succeeding years at then current prices. These projections permit a comparison between meteorological expenditures in 1965 with those in later years. Figure 3 depicts how much annual meteorological expenditures have exceeded (on a percentage basis) the real 1965 expenditure level. As may be seen, there was an average real increase of about 10 percent per year until 1968 and since then a general decline averaging nearly 3 percent per year relative to 1965. Overall, the net effect has been that meteorological expenditures in 1976 will amount to only 8.3 percent more than in 1965 in real terms, i.e., an average increase of approximately .8 percent per year.

In order to gain a more realistic perspective on just what this pattern of growth means in economic terms, it is helpful to compare it with the real growth of the economy as a whole during the same period. This has been done in Figure 3 by plotting the real annual change in the Gross National Product relative to its level in 1965. As may be seen from the graph, except for the recent decline, the Gross National Product has grown at an average rate of over 3 percent per annum. Since 1968, however, there has been a general declining trend in Federal meteorological expenditures both absolutely (at nearly 3 percent per year) and relative to the economy as a whole (at over 5 percent per year).

OVERVIEW OF FEDERAL EXPENDITURES AND MANPOWER IN OPERATIONAL METEOROLOGY

Figure 4 provides a breakdown of the Federal expenditures in operational meteorology for the Basic Meteorological Service and the major Specialized Services for aviation and military activities. The most significant increase is associated with the Basic Meteorological Service for which expenditures have grown about 242 percent over the past decade to a projected value of approximately $295,499,000 in fiscal year 1976. This change reflects the rise in manpower costs and the increased application of technology, such as computers, satellites, radar and aerial reconnaissance capability, to achieve service improvement.

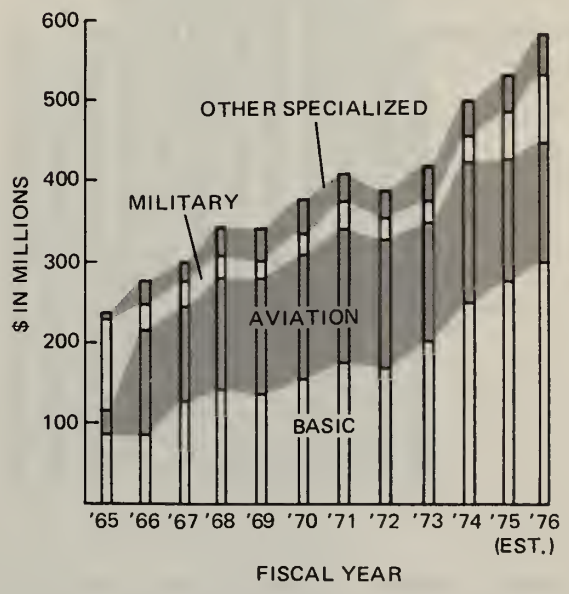


Figure 4.—Federal expenditures for meteorological operations, fiscal years 1965-1976.

Manpower engaged in operational meteorology (Fig. 5) peaked in fiscal year 1968 at 26,430 while fiscal year 1976 is projected at 20,826 which is about

the same as in fiscal year 1965. Most of this manpower is concentrated in the Departments of Commerce and Defense; other agencies accounting for approximately 14 percent of the total. The Department of Commerce has experienced an overall rise from 4,550 personnel in 1965 to a projected 6,584 in 1976, although decreases of 222 and 92 occurred in 1970 and 1972, respectively. The Department of Defense, on the other hand, had 13,706 personnel in 1965, 17,756 in 1968, and expects to be at 11,304 in 1976 for an overall decrease of 2,402 over the period. This decrease is primarily a result of the general reduction in the military forces. There was an additional decrease of 900 personnel this last year in the Coast Guard due to the termination of U.S. participation in the Ocean Station Program.

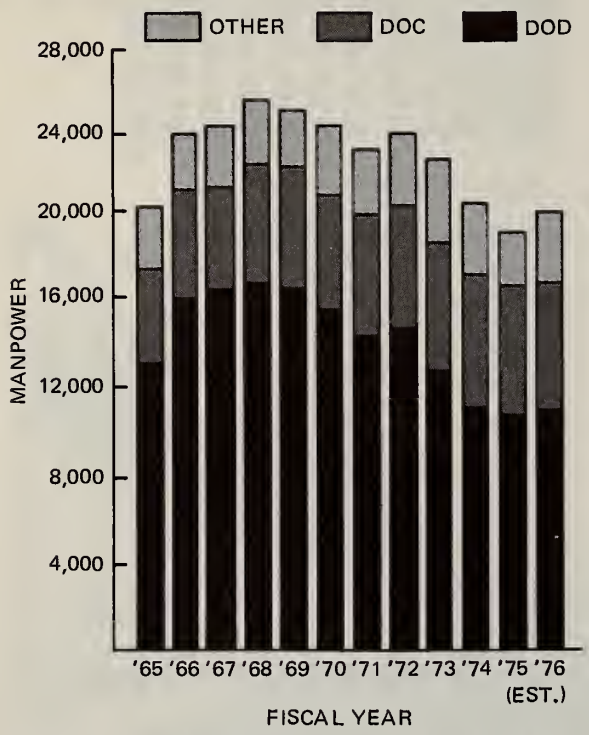


Figure 5.—Federal manpower in operational meteorology.

FORECAST AND WARNING SYSTEM

Three major functions are common to all Basic and Specialized Meteorological Services. These are monitoring, preparing forecasts and warnings, and disseminating forecasts and warnings. Research is an intrinsic part of these functions to insure their short- and long-term improvements.

MONITORING

An essential mix of meteorological observations underpins all weather services. The five basic categories are:

- Aircraft reconnaissance
- Radar observations
- Satellite observations
- Surface observations
- Upper air observations.

Aircraft Reconnaissance. The Department of Defense has for many years been providing aircraft reconnaissance of tropical cyclones and east coast winter storms to acquire essential storm data. Department of Defense weather reconnaissance efforts are supplemented by data from Department of Commerce aircraft funded under research activities. All reconnaissance is conducted under procedures established in the annual *National Hurricane Operations Plan* and the *National East Coast Winter Storms Operations Plan.*

Hurricane Camille in 1969 set the stage for most of the recent activities in aircraft hurricane reconnaissance. A Presidential inquiry into the weather services surrounding Hurricane Camille reflected some concern with the adequacy of aerial weather reconnaissance. As a result, certain progress has been achieved. The U.S. Air Force has completed action in modernizing the instrumentation aboard their updated reconnaissance aircraft of the C-130 type. The U.S. Navy has completed action to replace obsolete aircraft with newer WP-3 aircraft, including the provision of new and improved instrumentation. Beginning in FY 1976 these aircraft will soon be used for purposes other than hurricane reconnaissance. The U.S. Air Force will retain an aircraft weather reconnaissance force to satisfy military requirements which, in addition, will have the capability for meeting Department of Commerce requirements for aircraft reconnaissance. However, continued pressure on the Department of Defense budget will cause the Air Force to seek reimbursement in the future for those costs of the weather reconnaissance program which relate directly to the support of Department of Commerce requirements. Other options are also being investigated.

The National Oceanic and Atmospheric

Administration (NOAA) is phasing out its obsolete research aircraft. Action has been taken to update the instrumentation aboard a recently acquired C-130. One WP-3 aircraft was purchased in fiscal year 1974 and another in fiscal year 1975. These new aircraft will be equipped with advanced instrumentation. The major purpose of these aircraft is to conduct hurricane modification experiments--Project STORMFURY--in the Pacific beginning in 1977.

Satellites are important as a first line of defense in locating and tracking potential tropical storms and hurricanes while far out at sea, and radars are important as the final line of defense in furnishing data on actual storm intensity and landfall. Nevertheless, the role of aerial reconnaissance is expected to grow as the specific data that aircraft provide become indispensable to the application of numerical models in forecasting storm development and landfall many hours in advance.

Radar Observations. Radar is a major element in this Nation's natural disaster warning system. Radar is used also in providing observations that contribute to safety in the control of aircraft in flight. Plans have described a basic network of long-range radars to provide continuous severe weather surveillance over the Nation and to trigger the operation of local warning radars at sites where the threat of severe weather is imminent and the potential impact is great.

The basic network in 1965 consisted of 84 radars (32 Commerce, 52 Defense). Coverage was lacking over five full states and 26 partial states. After completion of fiscal year 1975 budget action, a basic network of 71 radars (56 Commerce, 15 Defense) will provide coverage that is only lacking over four full states and seven partial states. This additional coverage in 1975 vs. 1965 with 13 fewer long-range radars was realized through relocation and discontinuing the units with overlapping coverage.

The use of the Federal Aviation Administration's Air Route Traffic Control Center radars for weather information over the western states was initiated in May 1967. Expansion of this application to include four Centers involving their 22 radars has afforded the coverage shown in Figure 6 in which only minor gaps remain in radar surveillance of the United States. The Federal Aviation Administration is now in the process of automating its air traffic control functions which will result in useful weather radar signals being eliminated at the radar sites. The Department of Commerce has requested resources to resolve this problem.

In 1965, a total of 82 local warning radars was operated by the Department of Commerce. These are gradually being replaced as part of a Commerce

Figure 6.—Basic weather radar network coverage, fiscal year 1976 (includes FAA ARTCC radars in western U.S.).

program to provide 66 new local warning radars in areas susceptible to severe weather. The Department of Defense now operates 85 local warning radars.

Radar remote displays have been made available to augment the capability of weather service offices having warning responsibility. Repeater scopes are used where feasible. At other locations, properly equipped Federal and non-Federal users can communicate by means of telephone lines with radar sites (having remoting system transmitters) to follow the development of storms affecting their areas of interest in real time.

During the mid-1960s, a video integrator and processor technique was developed for providing a visual presentation of the intensity of radar echoes for use in estimating rainfall rates and amounts. There are 26 of these units in operation. In 1970, NOAA commenced an experimental project to digitize and process radar data automatically using minicomputers and digital data processing techniques to produce improved identification of severe weather including tornadoes, severe thunderstorms, and heavy rains that cause flash floods. Equipment has been installed at five operational radar sites for test and evaluation.

Satellite Observations. The past 15 years have witnessed some dramatic technological milestones (Fig. 7) that have greatly expanded the global observing capability of the Federal meteorological satellite program. Most of these advances have resulted from the parallel research and development effort in which new capabilities are developed which may then be transferred to the operational systems.

In fiscal year 1965 the forerunner (TIROS IX) of the first operational satellite (TOS/ESSA) series furnished merely a limited overview of global cloud systems over the sunlit portions of the earth. Meanwhile earlier in fiscal year 1965, Nimbus 1 had demonstrated global day and night coverage of cloud systems, and measurements of the global earth radiation budget, as well as direct readout of satellite pictures to low cost ground stations which were quickly put into operation worldwide by national weather stations and other meteorological interests. These and other capabilities have been incorporated in the operational system to the extent that in fiscal year 1975 the operational polar-orbiting satellites together with the Synchronous Meteorological Satellite (SMS) are making available high resolution

Satellite Launch Date	Capability Achieved	Satellite
April 1, 1960	Daytime cloud cover photography from space	TIROS I
Dec. 21, 1963	Direct readout of cloud pictures to local ground stations	TIROS VIII
Aug. 28, 1964	Nighttime cloud cover imagery	NIMBUS I
Jan. 21, 1965	Global daytime cloud cover photography in sun-synchronous orbit	TIROS IX
July 1, 1965	First operational satellite	TIROS X
Feb. 28, 1966	Inauguration of world's first operational satellite system	ESSA 1 and 2
Dec. 7, 1966	Continuous black and white cloud cover pictures from geosynchronous orbit	ATS 1
Nov. 5, 1967	Continuous color cloud cover pictures from geosynchronous orbit	ATS 3
April 14, 1969	Vertical temperature sounder	NIMBUS III
Jan. 17, 1970	Operational satellite with scanning radiometer (daytime and nighttime coverage)	ITOS 1
Oct. 15, 1972	Operational satellite with very high resolution radiometer and vertical temperature profile radiometer	NOAA 2
Dec. 12, 1972	Microwave spectrometer and electrically scanning microwave radiometer for vertical temperature profiles and sea-ice boundaries through clouds	NIMBUS 5
May 17, 1974	First geosynchronous operational environmental satellite with visual and infrared spin-scan radiometer	SMS 1
Mar. 10, 1975	Inauguration of two-satellite system for near-continuous viewing of United States and adjacent waters.	SMS 1 and 2

Figure 7.—Environmental satellite milestones.

global cloud imagery day and night; vertical temperature profiles of the atmosphere; near-continuous monitoring of weather systems; areal distribution of sea-surface temperatures, sea ice and snow; upper level wind information; direct broadcasts of facsimile data from meteorological analysis centers; and a capability for the collection and relay of environmental data from remote platforms.

The Geostationary Operational Environmental Satellite adds a new dimension of near-continuous imagery critical to improving the environmental warning services. The National Aeronautics and Space Administration (NASA) prototype satellites for this system were launched on May 17, 1974 (SMS 1), and on February 6, 1975 (SMS 2).

Polar-orbiting satellites include an automatic picture transmission system which permits immediate local readout of cloud imagery data using specially designed ground equipment. More than 190 government-operated stations have this equipment in approximately 100 different countries. Plans exist for the establishment of additional stations. Furthermore, there are over 400 stations operated by universities and other nongovernmental institutions as well as several hundred amateur stations.

The development of a third generation polar-orbiting operational satellite, designated TIROS N, reflects a three-way collaboration among the Departments of Defense and Commerce, and NASA. This operational system will be based upon the spacecraft of the Defense Meteorological Satellite Program with sensors developed by NASA, the United Kingdom and France. Current plans are to use Department of Defense launch services as well as launch vehicles on a reimbursable basis. Once in orbit, the civilian satellites will be operated by NOAA as part of the national operational environmental satellite service. Besides the advanced visual and infrared imaging sensors and improved vertical temperature profile and humidity sounding instrumentation, satellites of the TIROS N series will have the capability to locate and interrogate moving observation platforms such as drifting buoys and balloons.

Surface and Upper Air Observations. The total Federal surface land and marine observation sites, now amounting to 1,537, have increased by 67 even though the Department of Defense has experienced a reduction of 161 locations. The overall increase stems mainly from the addition of stations by the Departments of Commerce and Transportation.

A decrease in the number of locations with an upper air rawinsonde capability from 331 in 1965 to 183 in 1975 reflects mainly the general force reductions of the Department of Defense overseas and on board ships. Reductions were made also in the ocean station vessel program with the exception of Ocean Weather Station HOTEL. This station, manned by U.S. Coast Guard cutters, provides marine meteorological information that is vital to forecasts and warnings of east coast storms.

A number of techniques for automation of surface and upper air observations and for remote sensing of wind, temperature and humidity in the lower atmosphere were advanced during the past decade.

In fiscal year 1970, the first successful prototype automatic meteorological observing station was produced that will relieve the human observer from performing certain repetitive tasks such as reading basic meteorological instruments and transmitting data. Since then improved versions have been designed. Thirty-two stations are now in operation with a total of 106 complete and 86 limited stations planned. These include systems for use at remote unattended sites as well.

In early 1974 the first on-site minicomputer for processing upper air data from balloon borne instruments was installed in Anchorage, Alaska. Since then, 71 of a planned total of 99 have also been installed. Manpower savings can amount to one man per station.

To improve the detection of severe storms, a tornado detection system that is based on the measurement of burst rates of radio frequency atmospherics is being field tested. An infrared Doppler system is being developed to measure atmospheric velocities, including those associated with vortex phenomena such as dust devils, waterspouts, and tornadoes. Major progress has been made in the use of multi-station Doppler radars to measure the three-dimensional wind flow patterns in convective and orographic storms.

In 1972, the Environmental Protection Agency initiated a five-year regional air pollution study. This study, utilizing a network of twenty-five observing stations, should provide insight into the character and origins of pollutants within the atmosphere of a major urban area.

For many years the Energy Research and

Development Administration has operated a worldwide surface and upper air sampling program. A wide variety of radionuclides are measured along with other constituents. The data lead to improved understanding of the atmospheric general circulation and are used to build models for prediction of the local and global disposition of material released to the atmosphere.

FORECAST AND WARNING PREPARATION

Progress in forecast and warning preparation has been achieved through advances in computer technology, numerical model development and reorganization of forecast responsibilities.

Meteorological services and research programs within the Federal Government rely heavily on large-scale computers. These activities range from the preparation of day-to-day weather forecasts for the general public and special user groups to basic modeling research on atmospheric dynamics. Progress in operational forecasting and atmospheric modeling over the past 20 years would have been impossible without the concomitant developments in computer power.

Large-scale computers of the 1950s were barely adequate for operationally producing 24- to 36-hour forecasts. Large-scale computers of the 1970s are 1,000 times more powerful than those of the 1950s and the point has been reached where relatively high quality operational forecasts are possible for 3 days with promise of extension into the longer range. The exponential increase in large-scale computer capabilities permits research employing more realistic models in a wide variety of important scientific problems. The modeling problems under study cover a broad range of space and time scales from turbulence and convection phenomena to global climate change.

Hand in hand with the increase in quantity of meteorological data from satellites and other sources has been the development of increasingly sophisticated models requiring in turn more advanced analysis systems. The simultaneous development of high speed computers, new numerical techniques and models now make it possible to examine a broader range of meteorological phenomena (hurricanes, sea breezes, lake snowstorms and climatic changes) as well as develop new statistical techniques such as using model outputs in lieu of direct observations in deriving statistical forecasts.

Present numerical operational forecasts require up to 2.5 billion computations for a 24-hour forecast while general circulation research requirements are orders of magnitude higher. To support the operational needs, fourth-generation computers, capable of performing almost 10 million instructions per second are used at NOAA's National Meteorological Center and Air Force's Global Weather Central. Such computer capabilities are also planned for the Navy Fleet Numerical Weather Central.

The results of analyzing precipitation, temperature, wind, and pressure forecasts made during the past few decades show that progress, though sometimes slow and at times difficult for the public and other users of the products to notice, is definitely being made. Most of the improvements, however, have been for synoptic forecasts between 12 hours and five days. As yet, there has been relatively little improvement in the short-range forecasts of smaller scale phenomena.

A significant change over the past decade has taken place in the reorganization of the National Weather Service. This action increased the number of offices providing user-oriented forecast products from 25 area forecast centers to 52 weather service forecast offices. Advantages of the reorganized structure were demonstrated during the tornado outbreaks of April 3-4, 1974, (148 reported tornadoes), and June 8, 1974, (22 reported tornadoes). The forecast and warning system was able to respond much more effectively from a large number of offices with a smaller geographical area of responsibility than would have been the case in 1965 when the area forecast centers were responsible for several states.

The most destructive storms, in loss of life and property, are tornadoes and hurricanes. As the population of the United States has expanded over the last couple of decades, more tornadoes have been reported but there have been fewer deaths per million people or per million dollars of damage (see Fig. 8). The decrease in death rate is a reflection of improvement in both the forecast and warning service as well as in the reporting network, the communications system, and the community preparedness efforts.

With the application of the present and emerging observing and processing technologies there is a need for a mechanism to help the forecaster assimilate and assemble weather information. Routine demands upon a forecaster's time are severe; in addition,

warnings and forecasts, once produced, must be disseminated to users in time to be useful. For critical time-dependent actions, as exemplified by a tornado warning, as well as to assist the forecaster in assimilating and disseminating large amounts of information, a highly automated high speed weather service system is essential. Recognition of this need has resulted in a planned program called Automation of Field Operations and Services using minicomputers, a national distribution circuit and TV-type monitors. Funds requested in fiscal year 1976 will be used to provide for implementation of the program at about 300 weather offices nationwide.

FORECAST AND WARNING DISSEMINATION

Forecast and warning dissemination is a most critical link in the disaster warning system. Products of the observing and processing systems must be transmitted to users in sufficient time for decision making and for taking protective action. Such action is most important in the case of potential natural disasters as they affect the general public or weather hazards that impact aviation and marine interests.

Forecast and warning dissemination, 10 years ago, was done primarily by telephone contact from weather service offices to the mass media and then to the general public. Over the years, a multi-system approach has evolved in order to insure that the greatest number of people are warned of potential weather hazards and are provided with general weather information for use in their daily pursuits. Radio, television, telephone and teletypewriter systems are currently available for dissemination of warnings both directly into the homes and indirectly through the mass media to the general public.

In fiscal year 1965 the NOAA Weather Wire Service, which provides weather information to the mass media serving large segments of the population, was available in four states with partial coverage in 12

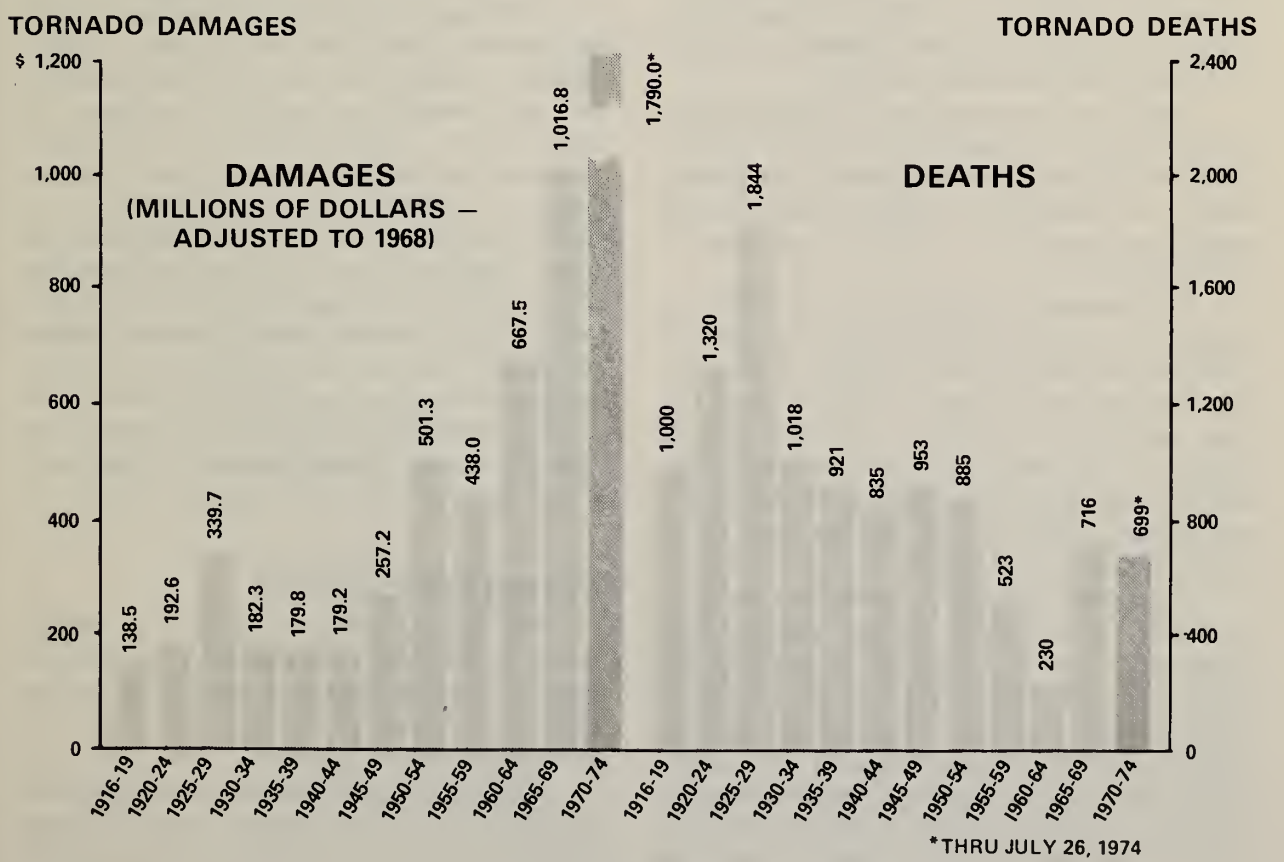


Figure 8.—Trends of losses from tornadoes in the United States.

additional states. This important service will soon be available in 48 states.

NOAA Weather Radio consists of VHF-FM transmission facilities that provide continuous broadcasts of weather warnings and forecasts direct from weather offices to the public. In fiscal year 1965 there were four stations in operation. In fiscal year 1975 this service consists of 77 stations. Through the use of a tone-alert device, specially equipped radio receivers can be turned on by the transmitter thus providing a positive and immediate notice of a warning. It is planned with funds requested in fiscal year 1976 to expand the network to 331 stations by 1979, which would make warnings available directly to approximately 90 to 95 percent of the Nation's population. A recent policy statement by the Office of Telecommunications Policy declares that the NOAA Weather Radio will be the only Federally sponsored system for transmission of natural disaster and attack warning information to home receivers optionally available to the general public.

The use of automatic telephone service to disseminate local weather information is gaining wide acceptance. In fiscal year 1965 this service was available in 18 cities. It has now expanded to 90 cities for a five-fold increase during the decade.

Coast Guard stations assist in disseminating weather forecasts and warnings to the public. Voice broadcasts pass weather information to the boating public, and fishing and merchant fleets. Coastal displays at many Coast Guard stations warn of impending storms.

The National Warning System (NAWAS) is designed to notify Federal agencies, the military, state governments, counties, and cities of an actual attack on the United States. Because NAWAS has been authorized for relaying warnings of natural disasters, it has become an important adjunct for warning dissemination. The National Weather Service has increased the number of NAWAS drops in its forecast offices from 29 to 245.

The Decision Information Distribution System is a recent development by the Defense Civil Preparedness Agency to provide a capability for simultaneous nationwide issuance of attack warnings directly to governmental institutions and agencies involved in disaster preparedness and rescue. A first distribution station at Edgewood, Maryland, covering 10 states is being tested. In consonance with the policy to use many systems in order to reach the greatest number of people, tests will also be run to disseminate weather warnings using this particular system.

The concept of a single system for natural disaster warning dissemination is being investigated by NOAA and NASA. This study effort is looking at the feasibility of using a communication satellite for this purpose.

Turning briefly to dissemination of weather information to pilots, it is noteworthy that the number of aircraft in general aviation has increased by about 50 percent and the number of pilots by over 50 percent during the past decade. The significance of these increases is manifested in the demand for aviation briefings. The number of briefings by the Federal Aviation Administration and the National Weather Service combined increased from 7.5 million in 1965 to an estimated 19.6 million in 1976. It is also worthy of note that the large increase in briefings by the Flight Service Stations of the Federal Aviation Administration was accompanied with a decrease in the number of stations from 380 to 320 during the period.

There are three programs designed to provide more wide-spread dissemination of aviation weather information to pilots. These are the pilots' automatic telephone weather answering service, the transcribed weather broadcasts, and public TV broadcasts. All three are joint Federal Aviation Administration/National Weather Service sponsored programs. Tests of the automatic telephone service involving separate numbers for various routes are being conducted in New York City and Washington, D.C. Installations will begin in June 1975 to increase the number of stations offering transcribed weather broadcasts from 104 to 140 by 1977. Aviation weather briefings on current and forecast weather conditions nationwide are televised two nights a week over 190 stations. Plans are underway to inaugurate a similar service on at least 5 mornings per week.

SYSTEM PERFORMANCE

The primary national objectives for weather service to the Nation are directed at reducing the impact of natural disasters, promoting the Nation's economy, enhancing environmental quality and strengthening national security.

The meteorological programs that support these objectives are under continuing review. Particular attention has been directed recently at the

performance of the natural disaster warning and preparedness system, including:

- The *Report to the Congress on Disaster Preparedness* by the former Office of Emergency Preparedness (OEP), January 1972.
- The report on the aftermath of Hurricane Agnes, *The Agnes Floods*, by the National Advisory Committee on Oceans and Atmosphere (NACOA), November 1972.
- Post-disaster surveys such as the one conducted by NOAA after the severe outbreak of 148 tornadoes in April 1974. Designation of a Presidential Objective in June 1973 to reduce the social and economic impact of natural disasters.

The OEP Report, the NACOA Report, and the post-disaster surveys highlighted strengths and weaknesses in the warning and preparedness system and identified many unmet needs. The OEP Report called for improvements in a broad range of warning and community preparedness activities. The NACOA Report recommended that priority attention should be given to the warning delivery systems. In its annual report for 1973, NACOA also recommended efforts to streamline field operations and services for the purpose of improving the overall performance of warning and forecast preparation and reducing warning dissemination time.

This Federal Plan for FY 1976 contains many program elements that are responsive to these recommendations in support of the Presidential Objective.

Summary of Fiscal Data

The following tables summarize fiscal information concerning meteorological expenditures of the Federal Government for meteorological services and supporting research for FY 1975 and FY 1976. Supporting research has as its immediate objective the improvement of meteorological services. Activities integral to Federal programs in weather modification, water resources, and air-sea interaction are not included within the purview of this Plan.

The fiscal information is presented for meteorological operations and for supporting research by Agency (Table 1) and by Service (Table 2) and consists of FY 1975 data and planned activities for FY 1976.

In FY 1976, agencies are requesting $574,754,000 for operational programs. This represents a net increase of $49,444,000 over FY 1975. The Departments of Commerce and Defense and the Federal Aviation Administration make up the bulk of this with reported increases of $24,916,000, $17,916,000, and $5,872,000 respectively. Changes in the FY 1975 figures over that reported in last year's Plan amount to an increase of $32,609,000. A portion of this change is due to the impact of inflation on program costs for all agencies. The Department of Commerce change of $20,597,000 is made up of a correction in program entries and an amendment in the FY 1975 budget request to include efforts to begin automation of field operational services and procurement and installation of weather radars. The Department of Defense change of $9,845,000 is mainly attributed to satellite operations.

Table 1.–Federal plan for meteorological operations and supporting research, by agency
(Thousands of dollars)

Agency	Operations			Supporting research			Total		
	FY 75	FY 76	Net difference	FY 75	FY 76	Net difference	FY 75	FY 76	Net difference
Agriculture	.....	.....	.....	1,341	1,387	+46	1,341	1,387	+46
ERDA	1,965	2,198	+233	462	479	+17	2,427	2,677	+250
Commerce	243,361	268,277	+24,916	13,530	13,866	+336	256,891	282,143	+25,252
Defense	213,524	231,440	+17,916	22,058	23,884	+1,826	235,582	255,324	+19,742
EPA	.....	.....	.....	8,430	8,430	0	8,430	8,430	0
NASA	1,128	1,365	+237	32,619	30,778	-1,841	33,747	32,143	-1,604
Transportation:									
Coast Guard	4,453	4,723	+270	.....	.....	.....	4,453	4,723	+270
FAA	60,879	66,751	+5,872	8,052	8,574	+522	68,931	75,325	+6,394
Total	525,310	574,754	+49,444	86,492	87,398	+906	611,802	662,152	+50,350

Table 2.--Federal plan for meteorological operations and supporting research, by service
(Thousands of dollars)

Service	Operations			Supporting research			Total		
	FY 75	FY 76	Net difference	FY 75	FY 76	Net difference	FY 75	FY 76	Net difference
Basic	269,527	295,499	+25,972	45,841	44,234	-1,607	315,368	339,733	+24,365
Aviation	181,371	196,949	+15,578	8,667	9,294	+627	190,038	206,243	+16,205
Marine	9,147	9,857	+710	1,349	1,468	+119	10,496	11,325	+829
Space Operations	8,434	9,341	+907	108	110	+2	8,542	9,451	+909
Agriculture	2,394	2,394	0	876	892	+16	3,270	3,286	+16
General Military	35,200	40,452	+5,252	20,244	21,946	+1,702	55,444	62,398	+6,954
Forestry	1,812	1,812	0	465	495	+30	2,277	2,307	+30
Air Quality	1,312	1,312	0	8,480	8,480	0	9,792	9,792	0
Other Specialized	16,113	17,138	+1,025	462	479	+17	16,575	17,617	+1,042
Total	525,310	574,754	+49,444	86,492	87,398	+906	611,802	662,152	+50,350

For FY 1976, the operational program increases being requested by the Department of Commerce are directed primarily toward reducing the economic and social impacts of natural disasters. The major high priority efforts include extending radar surveillance of severe weather and dissemination of weather forecasts and warnings nationwide, streamlining field operations to reduce delays in warning dissemination, and preparing for an improved weather satellite capability. Requests by the Department of Commerce for increased funding include $12,460,000 to apply modern methods of data handling, display, and communications for Automation of Field Operations and Services (AFOS) to provide more effective forecast and warning services to the Nation; $1,455,000 to complete the National Oceanic and Atmospheric Administration Weather Wire Service to the mass media across the Nation; $3,560,000 to provide the basis for making radio broadcasts of weather warnings available directly to the public; $2,000,000 planned for equipment to modify 22 Federal Aviation Administration traffic control radars in the western United States for remote transmission of weather data to weather offices; and $5,430,000 for procurement of ground station equipment, instruments and spacecraft for the next generation polar-orbiting spacecraft to obtain more accurate temperature profiles in cloud-free areas and soundings through clouds.

In the Department of Defense the most significant FY 1976 increase is $7,896,000 for satellite equipment and operations. Other major increases include $1,160,000 for procurement of tactical weather system radars; $2,100,000 for shipboard readout equipment; $803,000 for added aircraft reconnaissance operating costs; and $800,000 for procurement of ten Naval Environmental Display Stations for automated processing and displaying of meteorological and oceanographic information. Offsetting a portion of these increases is the deactivation of the U.S. Navy reconnaissance squadron at Jacksonville, Fla., which will reduce costs by $3,764,000.

Of the planned increase of $5,872,000 for Federal Aviation Administration in FY 1976, major items include air field observational equipment, equipment for transcribed weather broadcasts and radio equipment to provide en route flight advisory service from 45 Flight Service Stations for commercial and general aviation.

In FY 1976, the supporting research programs amount to $87,398,000 representing 41 percent of the total expenditures planned for meteorological research reported to the Interdepartmental Committee for Atmospheric Sciences. This represents a net increase of only $906,000 over planned expenditures by all the Federal agencies in FY 1975. There are a number of program increases within the

individual agencies, but these are offset by a decrease in funding requested by the National Aeronautics and Space Administration (NASA).

Changes in the FY 1975 supporting research figures over that reported in last year's Plan amount to a net increase of $2,533,000. The Departments of Defense, Commerce, and Agriculture and the Federal Aviation Administration reported increases of $3,884,000, $1,995,000, $308,000, and $352,000, respectively. These increases were offset by a NASA decrease of $3,998,000. The Department of Defense increase reflects funding for system support which had not been included previously, while the Department of Commerce increase is principally due to a redefinition of the research programs. NASA's reported decrease resulted from a decision to separate out those spacecraft, controls, and subsystems that are not directly associated with meteorological research.

For FY 1976 the Department of Defense budget reflects a planned increase of $1,826,000 for supporting research, largely directed toward improvements in meteorological support to the overall defense forces. NASA's budget reflects a decrease of $1,841,000 for FY 1976 because the major flight project activities on Nimbus F have been completed. NASA has now shifted emphasis to instrumentation, experimentation, and data analysis for Nimbus F and delayed program activities for Nimbus G and TIROS N.

Table 3 shows the distribution by agencies of operational costs between the United States and overseas areas. This table clearly illustrates the heavy investment in meteorological services required to meet military needs outside the conterminous States. Certain funds, such as those for weather reconnaissance and some contracts for missile range support, are included in the column headed "States" because funds are contracted for or reported by the parent unit within the United States, although the operations actually may be performed in overseas areas.

Table 4 shows the extent to which Federal agencies made use of each other's capabilities through the purchase of meteorological services and/or supporting research by interagency fund transfers in FY 1975.

The FY 1976 fiscal data contained in this Plan are reflected in the President's budget and should be used for planning purposes only. The scheduling and implementation of these programs after FY 1976 are subject to additional analysis and change. Fiscal data for the transition period, July 1 to September 30, 1976, will be contained either in a separate report or in the FY 1977 Plan.

Table 3.--Distribution of operational costs, conterminous states and overseas, by agency
(Thousands of dollars)

Agency	FY 75		FY 76	
	States	Overseas	States	Overseas
Commerce	232,202	11,159	257,741	10,536
Defense	172,964	40,560	189,620	41,820
Transportation:				
Coast Guard	747	3,706	795	3,928
FAA	52,417	8,462	57,740	9,011
ERDA	1,965	.....	2,198	.....
NASA	1,128	.....	1,365	.....
Total	461,423	63,887	509,459	65,295

Table 4.--Interagency fund transfers for meteorological operations and supporting research, fiscal year 1975

Agency		Funds [1]	
Transferred from	Transferred to	Operations	Research
ERDA	Commerce	1,546	432
DOD	Commerce	1,557	166
NASA	DOD (USAF)	7	.....
	Commerce	735	.....
FAA	Commerce	265	875
	NASA	.....	235
	ERDA	.....	4
	DOD	.....	50
DOC	NASA	34,079	.....
EPA	Commerce	.....	1,200

[1] Thousands of dollars.

Meteorological Services

INTRODUCTION

The objectives of the national meteorological services are to:

- Reduce the economic and social impact of natural disasters
- Promote the Nation's welfare and economy
- Preserve and enhance the environment
- Strengthen the national security.

To meet these objectives the Federal Government provides two types of meteorological services--Basic and Specialized. The Basic Meteorological Service for which the Department of Commerce has a central role meets public needs, fulfills requirements common to two or more agencies, and provides the foundation for disaster warnings and the specialized services. The Specialized Meteorological Services provide the facilities, products, and distribution mechanisms for servicing the needs of specialized users such as those involved in aviation, marine, space operations, agriculture, general military, and air pollution control.

BASIC METEOROLOGICAL SERVICE

Description

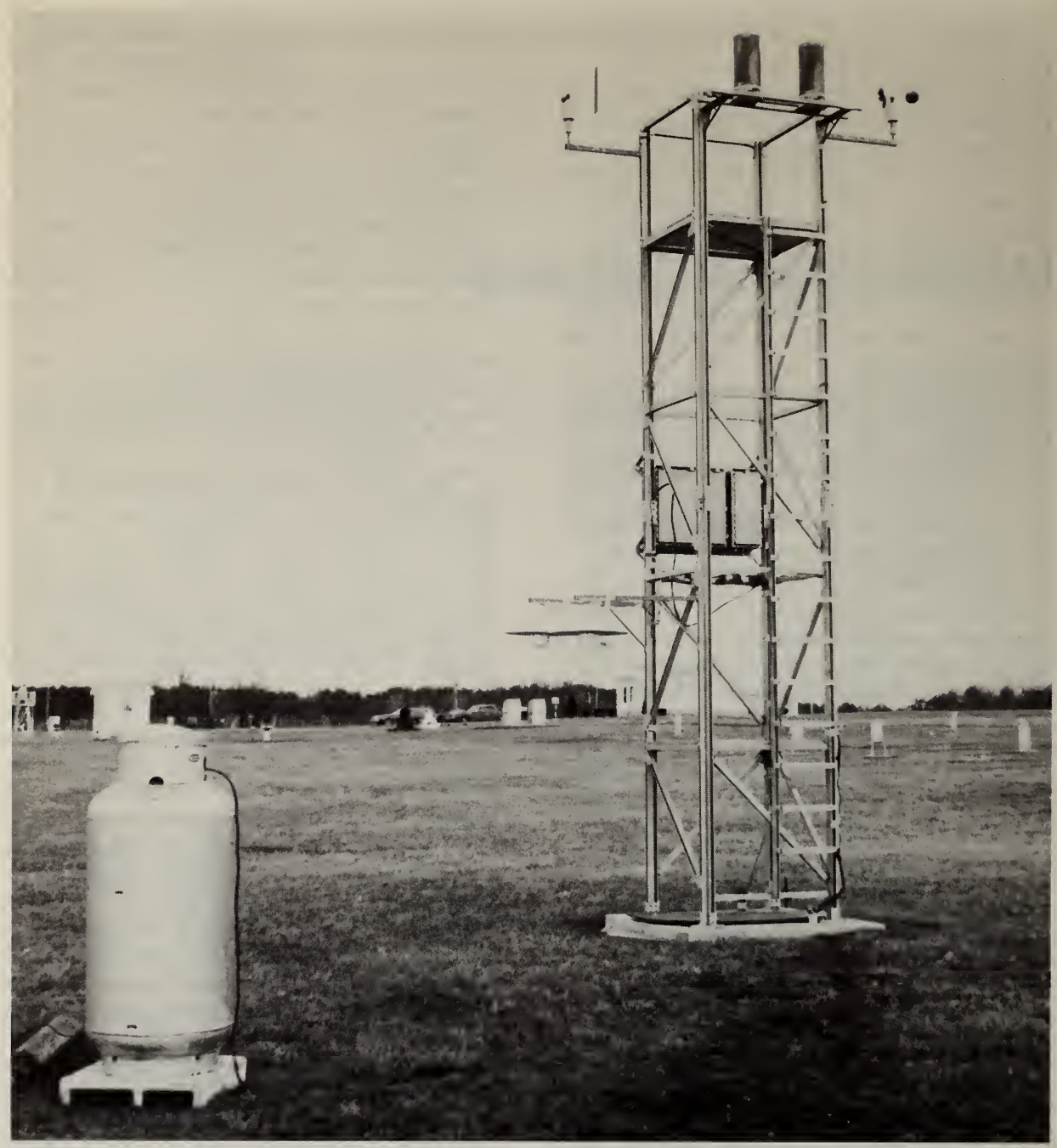
The Basic Meteorological Service provides fundamental observations and forecasts used by the general public, Departments and agencies of the Federal Government, and many segments of the economy. The effectiveness of the Basic Meteorological Service depends upon the cooperative efforts of several Federal agencies as well as upon the member nations of the World Meteorological Organization. The service includes the following five components:

- Observing the current weather conditions
- Communicating weather data and information
- Preparing analyses and forecasts
- Disseminating weather information to users
- Archiving weather information for ready retrieval.

The first of these components includes four fundamental weather observing programs--surface, upper air, radar, and meteorological satellite. These national programs are complemented by observations from around the world and provide the capability for detecting and tracking potentially hazardous weather and the essential data for basic analysis and forecast services.

Surface observations are made from fixed and mobile land facilities and from ships and buoys at sea. The Department of Commerce's basic observing network is supplemented by observations from Department of Defense land installations and ships at sea, U.S. Coast Guard stations and high endurance cutters, selected Federal Aviation Administration (FAA) control towers and Flight Service Stations, and from cooperative observers at locations without government facilities. For large-scale analysis and forecasting, the land observational network over the conterminous United States is adequate for most purposes.

Automatic weather stations are being increasingly used for essential observations from unmanned or inaccessible locations on land and sea. These stations are located in key areas to obtain weather observations for use in preparing tropical cyclone and winter storm warnings and day-to-day forecasts. There are presently 32 automatic stations located mainly in Alaska and the western United States plus 18 stations with limited sensor capability (e.g., wind data only). In addition, automated buoys are positioned off the Pacific northwest, the Gulf of Mexico, and off the mid-Atlantic coast. *The Federal Plan for Environmental Data Buoys* contains further information on buoys and their deployment.



Remote Automatic Meteorological Observation Station provides surface data from unmanned locations.

More automatic weather stations with improved remote sensing equipment that can accurately specify clouds, visibility, and precipitation will be required to fill gaps in remote areas, for moving in behind those agencies which curtail or close manned operations, and for small-scale observing networks in support of severe weather research.

The Basic Upper Air Observation Network (balloon) consists of land and ship facilities operated by the Department of Commerce, with the Department of Defense and National Aeronautics and Space Administration (NASA) participation at U.S. and overseas bases. Other than the need for Department of Commerce replacement of the

WC-130 Weather reconnaissance aircraft.

recently discontinued Department of Defense-operated network upper air station at Eglin, AFB, Fla., the conterminous U.S. upper air network is adequate for large scale forecasting purposes.

While there is a regular network of upper air stations in the United States, it is not economically feasible to have such a network covering the adjacent oceans and other data-sparse areas. There are programs, however, that help to fill some gaps. For example, the Department of Commerce funds the meteorological programs aboard the U.S. Coast Guard-operated and funded high endurance cutters manning Ocean Weather Station HOTEL off the east coast. This station provides vital data essential to timely and accurate forecasts and warnings of east coast winter storms and tropical cyclones. The Department of Commerce also funds meteorological programs on islands of the U.S. Trust Territory in the Pacific Ocean. Supplemental upper air data from data-sparse areas are provided by Defense weather reconnaissance flights. Other sources of data include the Cooperative Meteorological Rocketsonde Network as well as commercial, general, and military aviation in-flight pilot reports.

The Department of Defense performs tropical cyclone aerial reconnaissance in the Western Pacific in response to military requirements and in the Eastern Pacific, Atlantic Ocean, Caribbean Sea, and the Gulf of Mexico in accordance with the provisions of the *National Hurricane Operations Plan*. Responsibilities for Department of Defense aircraft reconnaissance support were redefined at the Interdepartmental Hurricane Conference held in January 1975. In general, up to eight fixes may be requested whenever a storm is forecast to be within 300 nautical miles of the U.S. coast, Puerto Rico, the Virgin Islands, or Department of Defense installations. In the eastern and central Pacific Ocean, up to two consecutive 6-hourly fixes may be requested whenever a storm is forecast to be within 300 nautical miles of U.S. territory. In addition, extratropical winter storm reconnaissance is flown in the western Atlantic in accordance with the provisions of the *National East Coast Winter Storms Operations Plan*.

The Basic Weather Radar Network includes 51 Department of Commerce and 15 Department of Defense radars along with 22 FAA Air Traffic Control radars which are used to provide data from the western U.S. mountainous areas. Weather radars are a major factor in detecting and tracking significant weather events. Basic network radars have long-range detection capability and are manned around the clock to provide continuous severe storm surveillance. Local warning radars complement this network at 43 locations and provide on-call observations for selected metropolitan areas of the Nation susceptible to severe weather occurrences. Local warning radar data serve as the basis for detailed short-period warnings and forecasts.

Currently, there are several gaps remaining in the basic network. There is also a need for local warning radars to both replace outmoded World War II equipment and to expand coverage to those areas having frequent severe weather. In addition, added instrumentation is needed to increase the effectiveness and distribution of the data. The *Federal Plan for Weather Radars* describes detailed agency plans for this program.

The FAA is in the process of automating the Air Route Traffic Control (ARTC) system. The FAA radars used as part of the basic network in the mountainous regions of the west are being modified to improve aircraft control, but, unfortunately, this reduces the amount of weather data transmitted into the ARTC Centers for processing by radar specialists of the National Oceanic and Atmospheric Administration (NOAA). To insure no degradation in the availability of radar observations needed for detecting and tracking severe weather over this large region, programming is required for obtaining the weather data directly at ARTC radar antenna sites for transmission to control centers and forecast offices.

Meteorological satellites are the fourth of the Basic Meteorological Service's programs for observations. There are two types of satellites--geostationary and polar-orbiting--used to obtain information. Geostationary satellites are fixed relative to the earth and thus provide data at frequent intervals essential to environmental warning services but from limited geographic areas. Polar orbiters provide cloud imagery and vertical temperature profiles over the entire earth twice each day for environmental prediction purposes. Satellites of this type are funded by the Departments of Commerce and Defense. Department of Commerce and NASA are cooperating in the development of a new generation polar-orbiting satellite designated as TIROS N. Department of Defense facilities will be used for launching of this satellite. In addition, improved space technology from the Department of Defense system will be used for TIROS N to insure commonality whenever possible.

Prototypes of the Geostationary Operational Environmental Satellite (GOES) are being provided by NASA's Synchronous Meteorological Satellite (SMS) program. SMS 1 and 2 are now in position to provide near-continuous high-resolution cloud pictures over most of North and South America and adjacent waters. Because of the capability of GOES to detect and track severe weather, these satellites will contribute to improvements in the timeliness and accuracy of warnings.

Detailed descriptions of the satellite program are given under "Meteorological Satellites" beginning on page 67.

The utility of the Basic Meteorological Service depends upon an adequate communications network. Weather observations are collected and distributed nationally by teletypewriter systems operated by the FAA, NOAA, and the Department of Defense. Exchange of data between nations is accomplished by international and Department of Defense weather communications circuits linking the U.S. with overseas data sources. Using these observations, a forecast center prepares weather charts and forecasts for transmittal to specialized forecast centers, forecast offices, local weather offices, and other government and authorized private users over Departments of Commerce and Defense facsimile networks and teletype circuits.

The basic analysis and forecast products for all Federal agencies and industrial and commercial users are provided by NOAA's National Meteorological Center (NMC) in Maryland. NMC is the source for national and hemispheric analyses and forecasts which are the bases for warnings of potential weather disasters and for products issued by the specialized services. Approximately 400 separate charts depicting analyses and forecasts of atmospheric conditions at various times in the future are issued each day. Emergency backup for NMC is provided by the Air Force Global Weather Central in Nebraska and by the Navy Fleet Numerical Weather Central in California in accordance with the *Federal Plan for Cooperative Backup Among Operational Processing Centers*. At present, a need exists to upgrade the computer

SMS/GOES 1 photo at 1800GMT on Feb. 24, 1975. Cold front along east coast of U.S. was previously associated with 31 tornadoes reported on Feb. 22-23, 1975, in six south-central states.

operation at the Air Force Global Weather Central and the Navy Fleet Numerical Weather Central to allow for added processing loads.

The NMC operation is designed to produce forecast guidance products on a scheduled basis. Computer support for processing both NMC and National Environmental Satellite Service products are currently satisfied by two advanced computers on a shared basis. However, because of increasing demands resulting from new model developments (e.g., new hurricane prediction techniques) and from increases in satellite data, expansions in the main memory and in data storage capability are required. The *Federal Computer Plan for Operational Forecasting and Atmospheric Modeling Research* reflects detailed agency proposals for the acquisition and use of computers over the next five years.

In response to the need for streamlining and improving field operations, NOAA's National Weather Service (NWS) has a significant automation effort underway. Conceptually, the Automation of Field Operations and Services (AFOS) Program cuts across

almost the entire NWS field structure. The aim is to apply modern methods of data handling, display, and communications to the needs of field offices to provide more effective forecast and warning services to the Nation. The *AFOS Program Development Plan* calls for time-phased implementation throughout the NWS field operation over the next five to six years. Minicomputers, mass storage capability, TV-type displays, and hard-copy devices modularly assembled will be used to equip a Systems Monitoring and Coordination Center, four national centers, 14 River Forecast Centers (RFCs), 52 Weather Service Forecast Offices (WSFOs), and some 200 Weather Service Offices (WSOs).

The coordination center, national centers, and the WSFOs will be interconnected with a telephone quality full-duplex communications line called the National Distribution Circuit. Alphanumeric and graphic data will be carried throughout the system at 2,400 bits per second, significantly increasing NOAA's communications capability and replacing several internal teletypewriter and facsimile circuits. In addition, through the use of the minicomputer, each WSFO will be the interface, within its area of responsibility, with WSOs. The WSFOs will serve as the collection points for data and act as automated dissemination points for forecasts, warnings, and other information.

AFOS prototype equipment for an experimental WSFO, WSO, and RFC have been installed at the

AFOS forecaster console prototype.

NWS Headquarters. The NMC is interconnected by means of a communications link with this equipment as an integral part of the model facility. Procurement of initial equipment for operational installation at three WSFOs, two WSOs, one RFC, the Systems Monitoring and Coordination Center and completion of the NMC interface are underway.

The general public receives weather forecasts and warnings through a multiple mix of dissemination techniques designed to reach, either directly or through an intermediary, people engaged in normal day-to-day activities including work, recreation (e.g., boating, camping) and travelling. The methods used include teletypewriter (NOAA Weather Wire Service and the press wire services), NOAA Weather Radio, recorded telephones, Coast Guard radio systems, and through the mass media (radio, television, and newspapers).

The NOAA Weather Wire Service is now available, either throughout or in parts of, 35 states. There are on the order of 2,500 subscribers currently using this service. This method is most valuable in reaching the mass media with hard copy for retransmission of information to the public. Department of Commerce funds for the lines from a WSFO to telephone companies in any location within a state having a radio, TV station, or daily newspaper. Subscribers pick up the costs for terminal equipment and for connection and local line charges. Completion of this service in the conterminous 48 states is needed to increase the number of people who will be provided weather warnings and forecasts from several hundred more potential subscribers to the weather wire system.

The NOAA Weather Radio, operating at 162.4, 162.475, or 162.55 MHz, provides continuous radio broadcasts out to about 40 miles from the transmitter site. In an important policy statement issued by the Office of Telecommunications Policy of the Executive Office of the President on January 13, 1975, the NOAA Weather Radio was designated as the only Federally sponsored method for the transmission of natural disaster warning information to receivers optionally available to the general public. There are several inexpensive receivers available on the market. In addition, an increasing number of manufacturers are including a "weather button" as part of a regular AM or FM radio. Special receivers with tone-alert features are especially important in disseminating warnings to disaster agency and police officials, schools, institutions, and local governmental offices. This service is now provided from 77 locations and 46 additional transmitters are now on hand. The importance of completing this vital service throughout the Nation was demonstrated conclusively during the April 3-4, 1974, widespread tornado outbreak. At the few locations with NOAA Weather Radio available in the tornado outbreak area, continuous transmission of severe thunderstorm and tornado warnings proved to be of special value in alerting officials as well as the general public, and thus contributed to keeping the loss of life at a remarkably low level considering the circumstances.

The collecting, summarizing, archiving and retrieval of data are climatological activities within the Basic Meteorological Service. Climatology includes the continuing use of historical weather data for long-range planning and for improving knowledge of weather and its effects upon life, property, energy resources, and economic development. The *Federal Plan for National Climatic Services* presents agency activities and plans for improving services during the next few years. Because of the increasing importance of climatic fluctuations upon global food and fiber production and energy shortages, a new Environmental Data Service Center for Climatic and Environmental Assessment has been established and is discussed under Agriculture Meteorological Service.

An important step taken by NOAA's Environmental Data Service was the activation of its Environmental Data Index (ENDEX)/Oceanic and Atmospheric Scientific Information System (OASIS) for the continental United States. ENDEX/OASIS provides users with rapid referral to available environmental data and information files of NOAA, other Federal agencies, state and local governments, universities, research institutes, and private industry. ENDEX contains computer-searchable descriptions of atmospheric data. OASIS is a computerized information retrieval service that provides ready reference to atmospheric technical literature including bibliographic references, abstracts, and indexing terms. Most of the activities of collecting, summarizing, archiving, and retrieval of data are performed at the Environmental Data Service National Climatic Center (NCC), Asheville, N.C. The NCC also statistically applies and develops analytical and descriptive products to meet user requirements. It is the collections center and custodian for all U.S. weather records and provides facilities for the World Data Center A (Meteorology and Nuclear Radiation).

Table 5.--Basic Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
Commerce	216,113	241,029	13,380	13,616	229,493	254,645
Defense:						
Navy	12,809	12,206	.....	.....	12,809	12,206
Air Force	26,145	28,323	.....	.....	26,145	28,323
NASA	.....	.....	32,461	30,618	32,461	30,618
Transportation:						
Coast Guard	3,591	3,808	.....	.....	3,591	3,808
FAA	10,869	10,133	.....	.....	10,869	10,133
Total	269,527	295,499	45,841	44,234	315,368	339,733

The Basic Meteorological Service operations and research programs for FY 1976 are described in the following paragraphs. Table 5 lists the costs of the Basic Meteorological Service, by agency, for FY 1975 and 1976.

Operational Program for Fiscal Year 1976

Of those agencies participating in the Basic Meteorological Service, increases of $24,916,000 are planned by the Department of Commerce, and $1,575,000 will be applied to this service by the Department of Defense. The Department of Transportation plans a decrease of $519,000. The Department of Commerce's increased efforts are directed primarily toward reductions in the economic and social impacts of natural disasters. The major high priority efforts include extending radar surveillance of severe weather and improving the dissemination of weather forecasts and warnings nationwide, streamlining field operations to reduce delays in warning dissemination, and preparing for an improved weather satellite capability.

Remaining gaps in the Basic Weather Radar Network are programmed to be filled over the next two years using base funding. In FY 1976, previously purchased long-range radars are planned to become operational in southern Virginia, east Texas, and southern New York. During FY 1977 long-range radars will be installed in eastern North Dakota and northwestern Nebraska to fill large gaps in the network. In addition, of the 66 new local warning radars planned, 46 are now on order and installation will begin in FY 1976 along with procurement of 14 more local warning radars. Implementation of all local radars is planned to be completed within the next two to three years. Completion of the radar plan will result in nation-wide surveillance of severe storms. To insure maximum exchange and use of the information, procurement of radar data processors and transmitters for 56 network and 15 local warning radars will begin in FY 1976 using base funding.

As a result of the FAA Air Route Traffic Control Center modernization, Department of Commerce plans call for a $2,000,000 increase to purchase new equipment designed to continue transmission of full weather information from the FAA antenna sites in the mountainous areas of the west. The $2,000,000 increase will be offset in part by a decrease of $75,000 resulting from reduction of four program management positions in the National Weather Service. This is by far the most economical alternative for obtaining weather data from this region since the cost of procuring, installing, and operating of replacement weather radars in the western mountains would be prohibitive.

An increase of 5 positions and $12,460,000 is planned for the AFOS Program that is expected to lead to significant improvements in the national forecast and warning systems. This increase will permit procurement of equipment for continuing field implementation at four national centers, 23 WSFOs, 41 WSOs, and four RFCs. It also provides for

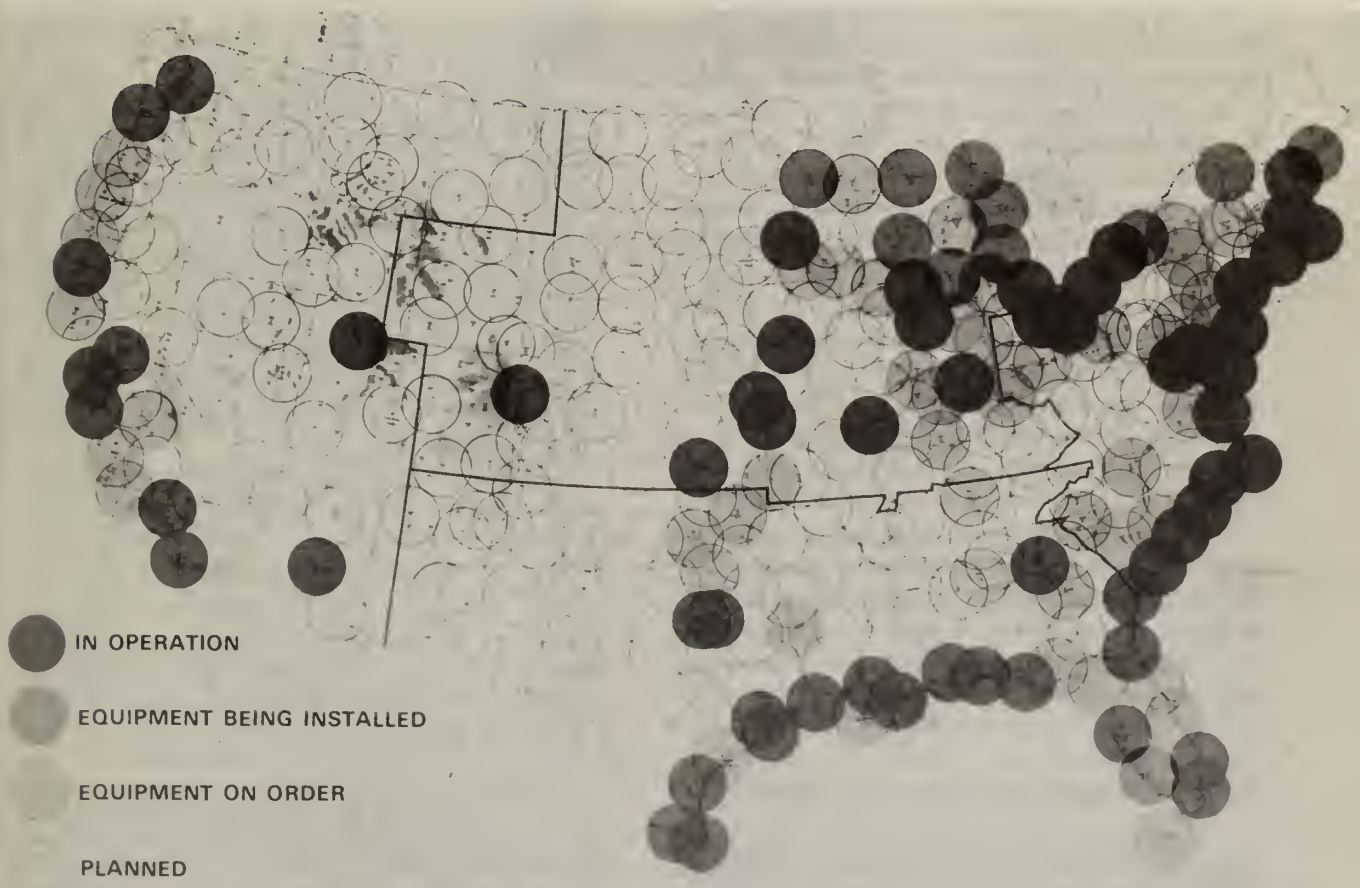
accelerated software development and the staffing of the monitoring and coordination center needed to ensure a smooth transition from a manual to an effective and efficient man-machine field operation. No further funding increases are anticipated for completion of the AFOS Program.

The Department of Commerce plans completion of two major dissemination systems--NOAA Weather Wire Service and NOAA Weather Radio. These systems are especially important in disseminating severe weather warnings. The planned NOAA Weather Wire Service increase of 49 positions and $1,455,000 in FY 1976 will add 13 states to the current 35 thus completing coverage in the conterminous U.S.

Installation of the 46 NOAA Weather Radio units now on hand will bring the number of radio transmission facilities to 123. The increase of $3,560,000 planned for FY 1976 will permit completion of this system at an additional 208 locations over the next three years. The total of 331 transmission sites will make continuous radio broadcasts of severe weather warnings and forecasts available to over 90% of the Nation's population.

Procurement of ground station equipment, instruments, and spacecraft for the third generation (TIROS N) polar-orbiting spacecraft supported by an increase of $5,430,000 is planned by the Department of Commerce for FY 1976. TIROS N improvements will include more accurate temperature profiles in cloud-free areas and soundings through clouds. TIROS N represents a collaborative effort involving NASA and the Departments of Commerce and Defense.

As part of a continuing program to automate observations from unmanned and inaccessible locations, base funding will be used in FY 1976 to install 15 more automatic meteorological stations. In addition, 10 stations capable of providing limited data will be installed. Future plans call for a total of 106 complete and 86 limited automatic stations.



NOAA Weather Radio Network.

A funding increase of $118,000 and four positions is planned for Appalachicola, Fla., to operate the network upper air station discontinued by the Department of Defense in FY 1975. This requirement will be offset in part by a decrease of $75,000 resulting from reduction of four regional headquarters positions. Minicomputers for processing of upper air soundings will be installed at 24 network locations out of base funding in FY 1976 bringing the total to 95 stations.

Additional main memory and storage capability planned for the NOAA computer complex at Suitland will cost $928,000. This expansion is required for meeting the demands of new and improved forecast models and for the processing of increased satellite data.

A net increase of $1,575,000 is planned by the Department of Defense in support of the Basic Meteorological Service. The requirements for aircraft reconnaissance of tropical cyclones were revised at the Interdepartmental Hurricane Conference held in January 1975. Department of Defense plans for FY 1976 indicate that the 10 aircraft needed to satisfy Department of Commerce requirements will be available from the Air Force for aerial weather reconnaissance through September 1976. Because of relative priority and fiscal constraints, the Navy's Weather Reconnaissance Squadron Four, however, will be disestablished prior to July 1, 1975. This will reduce Department of Defense funding by $3,764,000. Offsetting this reduction will be a number of increases attributed in part to the Basic Meteorological Service. Some of the more significant ones include satellite improvements for broader data coverage to match the world-wide scope of Department of Defense operations and computer upgrading for faster service essential to decision making.

In the Department of Transportation, the U.S. Coast Guard plans little change in its operations for FY 1976, while FAA will have a decrease of $736,000 resulting from reduced procurement and installation of teletypewriters at airport flight service stations.

Research Program for Fiscal Year 1976

Supporting research for the Basic Meteorological Service is provided by the Department of Commerce and NASA. In FY 1976, Department of Commerce funding is planned to continue at about the same level. NASA expects a decrease amounting to $1,843,000.

Department of Commerce's on-going efforts using base level funding will emphasize:

- Automation
- Equipment development
- Improvements in hurricane, severe storm, and short-period forecasts
- Establishment by Department of Commerce of a techniques development unit at the National Severe Storms Forecast Center.

Advancements in automation and equipment technology represent the common thread weaving through many of these research activities with particular emphasis on minicomputers.

Within the R&D aspects of the AFOS Program, design efforts will focus on the interfaces between the National Centers at Washington, Miami, Kansas City, and Asheville, together with an overall systems monitoring and coordination center at Washington. Evaluation of the initial field implementation scheduled for FY 1976 also will begin.

Department of Commerce plans to continue development work on automatic weather observing stations to improve their effectivenss and versatility. Modules will be tested and evaluated for measuring clouds-over-station, backscatter visibility, and water-soil temperature, evaporation, tide/wave heights, soil moisture and fuel moisture. Automatic stations are being adapted for shipboard use to fill the need for observations from ships at sea and for climatological purposes from land stations because of the increasing difficulty in obtaining cooperative manual observations.

One of the most important problems in weather observing is the positive identification of tornadoes. New Doppler and laser radar developments show promise of alleviating this problem. In addition, several other activities are underway which are designed to improve the handling and presentation of radar data. These include digitization of weather radar images, equipment calibration improvements, and elimination of anomalous propagation and ground return problems.

NASA's planned decrease in funding for supporting research is due to the completion of major flight project activities on Nimbus F and the delay of program activities for Nimbus G and TIROS N. Emphasis has now shifted to data analysis and

development of new instrumentation for possible future flight missions.

High priority will be given to continuing field evaluation of the high frequency tornado detection system with direction finding capabilities. Additional evaluation data are being collected, and it is anticipated that these sensors, when fully operational, will help to reduce the time between detection, warning, and emergency action.

A number of experiments are being conducted using ground based remote sensing techniques, either passively listening or actively probing the environment with a burst or beam of energy. The purpose of the research is to find practical ways of providing detailed atmospheric information such as the distribution of wind, temperature, aerosols, trace gases and hydrometeors not normally detected with the broadly spaced surface observational network. Equipment being tested to measure one or more of these elements include dual Doppler radars, frequency-modulated continuous wave radars, laser radars, and acoustic sounders.

Emphasis also will be placed upon the severe local storms observations and forecasting research programs. Theoretical principles need to be validatcd by relating frequent observations to the development of realistic models of severe local storm processes and phenomena. Delineation of the fields of motion within convective storms by dual Doppler radar will be combined with coordinated observations from a network of surface, instrumented tower, upper air, radar, aircraft, and satellite systems. These will help provide a comprehensive description, explanation, and fundamental understanding of severe storm characteristics and will lead to improved warnings and forecasts. Real-time displays of the wind velocities obtained using the dual Doppler radar system will be used for control of the observational program.

Research is continuing on forecast techniques designed to improve our capability to predict the occurrence or movement of adverse weather conditions. Two models for predicting hurricane movement will be tested and compared during the 1975 hurricane season with a view toward achieving improved 24-hour landfall errors. Intensive efforts will be made to improve specification of severe weather outbreak areas and their subsequent motion. As part of the AFOS forecast application program, techniques for producing computer worded public forecasts are being completed and refined for extensive testing.

AVIATION METEOROLOGICAL SERVICE

Description

The Aviation Meteorological Service furnishes specialized weather information to pilots, dispatchers, air traffic controllers, and fixed base operators to promote safety, efficiency, and operational effectiveness in civil and military aviation. Responsibility for the Service is shared among three Federal Departments--Commerce, Transportation, and Defense.

- The Department of Commerce provides meteorological services used by domestic and international civil aviation, and is responsible for meeting the common requirements of other agencies.
- The Department of Transportation makes recommendations to the Department of Commerce on civil aviation meteorological services, provides specialized equipment and surface observations at certain airfields, disseminates weather information to users, and distributes weather data over civil teletypewriter systems.
- The Department of Defense serves the specialized global needs of military aviation and makes meteorological information from its facilities available to civil aviation.

Specialized surface observations, primarily in support of aviation, are made at 525 civil and military locations in the United States. On the civil side, Department of Commerce provides these observations at 8 locations and the FAA at 348 locations. The remainder are provided by Department of Defense. These figures do not include cooperative observations by private operators at many smaller airports and those supporting the Basic Meteorological Service. At several locations the surface observation program is coordinated between the Department of Commerce and FAA or Department of Defense.

Pilot reports supplement surface observations by describing weather conditions encountered by aircraft in flight. They are essential for pilot weather briefings and as data for the issuance and updating of forecasts and warnings. A program was developed in 1975 to encode pilot reports in a standardized format similar to surface observations and aviation terminal forecasts. This will insure maximum use as essential weather data in the aviation program.

Weather observations and other information in support of domestic civil aviation are collected and distributed over the FAA teletypewriter Service A

and the Basic Meteorological Service teletypewriter systems. Department of Defense agencies use a continental U.S. meteorological teletypewriter system to meet the needs of military aviation and ground units in the United States. International meteorological data are exchanged on high-speed systems of the Basic Meteorological Service, and where necessary on the Aeronautical Fixed Telecommunications Network operated by FAA. The automated weather network of the Department of Defense provides for high-speed collection and relay of data between overseas areas and the continental United States to meet Department of Defense aviation and other military requirements. Data from this system are provided to the National Meteorological Center (NMC) as an essential ingredient to NMC's data base. NMC places selected North American data on the Department of Defense network for distribution to military users.

Analyses and forecasts for aviation are prepared by weather centers, and by weather forecast and service offices. As discussed later in the General Military Meteorological Service section, Department of Defense operates two primary centrals, two area guidance centers, and three specialized centers in the U.S. in support of military requirements.

National centers of the agencies provide guidance and forecasts for use by lower echelon forecast offices. At some of these centers cooperative efforts are in being to facilitate the exchange of information between agencies. For example, at the Navy's Fleet Weather Central in Hawaii normally three National Weather Service people assist in computer programming and adapting Navy products for use by the National Weather Service in the Pacific region. At Suitland, Md., the Naval Fleet Weather Facility provides operational sea ice analyses to the National Oceanic and Atmospheric Administration (NOAA) and back-up communications for transmission of meteorological products out of the NMC if required. Private industries obtain meteorological products from the NMC over computer-to-computer links, at no cost to the Federal Government, for computerized flight planning. The Department of Defense prepares computer flight plans--an average of 700-800 daily--to support worldwide tactical and strategic aircraft movements. In the event that NMC's computational center should experience a significant outage, arrangements have been made, as outlined in the *Federal Plan for Cooperative Backup of Aviation Winds Forecasts*, for the Air Force Global Weather Central to provide aviation wind forecasts for commercial flight planning.

Analysis and forecast centers of the Department of Commerce distribute specialized weather charts for aviation purposes to weather offices and briefing facilities including Weather Service Forecast Offices (WSFOs), Weather Service Offices (WSOs), FAA Flight Service Stations (FSSs), and military offices, over the National Aviation Meteorological Facsimile Network. The Department of Defense operates additional facsimile circuits to meet its specialized requirements.

Fifty-two NOAA WSFOs (including San Juan) prepare detailed local forecasts for 464 terminals and 298 routes on a scheduled basis, and six NOAA WSFOs provide forecasts for international civil aviation for the North Pacific, North Atlantic, and Caribbean areas and for Central America and West Europe according to procedures recommended by the International Civil Aviation Organization. Four Department of Defense weather service offices also support international civil aviation in the interest of efficiency and economy.

Aviation weather briefings by the Departments of Commerce and Defense and the FAA are available to pilots through 640 manned facilities. At the air terminals where a NOAA-WSO and an FAA-FSS are collocated, FSS personnel primarily handle the routine weather briefings. Users requiring more technical meteorological assistance are referred to the NOAA-WSO or to the nearest WSFO. FAA has a telephone network linking airports that do not have a local weather briefing outlet to a nearby FSS. Pilots use this network to file flight plans and to obtain preflight weather briefings. Additionally, the pilot on the ground may dial a pilot's automatic telephone weather answering service at 60 locations to receive recorded forecasts covering a 250-mile radius, plus 10 additional locations that cover the local area only. The pilot in the air may obtain weather observations, forecasts, and advisories on scheduled broadcasts from over 800 air navigation aids and as continuous transcribed weather broadcasts from 104 radio outlets. He may also get weather information by direct radio contact with a Flight Service Station. At four FSSs along the west coast, specially trained personnel provide additional air-ground radio service for pilots over a discrete radio frequency. This service, designated en route flight advisory service, maintains a continuous weather watch, provides

time-critical assistance to en route pilots facing hazardous or unknown weather, and recommends alternate or diversionary routes. These four FSSs are also focal points for rapid receipt and dissemination of pilots' reports and other weather information.

The Department of Defense operates a network of air-ground radio facilities to provide observations, forecasts, and warnings on request to airborne military pilots and to obtain in-flight weather reports from military aircraft.

FAA provided over 15 million pilot weather briefings last year, NOAA about 1.5 million, and Department of Defense approximately 2 million. FAA projects a continuing annual increase in requests for weather services from its Flight Service Stations. The number of pilot briefings from Flight Service Stations is expected to be 17.5 million in FY 1975 and increase to 19.6 million in FY 1976.

The FAA and NOAA are cooperating in providing aviation weather outlooks for weekend flying over the Public Broadcast System television stations. Since the inception at a Baltimore station about two years ago, a tremendous expansion of this aviation weather program has occurred. About 180 stations in 44 states now air this show.

Needs exist for responding to increased briefing requirements and to replace outdated radio and observational equipment. Improvements also are required in data handling and in forecasting of severe weather, ceiling, visibility, slant range visibility, precipitation, wind velocity and wind shear for use in aircraft operations. Finally, techniques are required to provide:

- Automatic measurements of cloud height and amount
- Automatic measurements of visibility
- Slant range visibility
- Runway visual range measurements at 100-foot increments down to zero visibility
- Automatic measurements of precipitation
- Low-level wind shear including wake turbulence vortices.

Department of Defense improvements needed for military aviation weather service support include observational information from ground and space systems and improved handling of weather information. These are further described under the General Military Meteorological Service section.

Table 6 lists the costs of the Aviation Meteorological Service, by agency, for FY 1975 and FY 1976.

FAA Flight Service Station telephone briefing.

Table 6.--Aviation Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
Commerce	19,753	19,753	25	100	19,778	19,853
Defense:						
Navy	11,506	12,150	590	620	12,096	12,770
Air Force	99,679	107,980	.....	.....	99,679	107,980
Transportation:						
Coast Guard	423	448	.....	.....	423	448
FAA	50,010	56,618	8,052	8,574	58,062	65,192
Total	181,371	196,949	8,667	9,294	190,038	206,243

Operational Program for Fiscal Year 1976

The Departments of Transportation and Defense are planning respective increases of $6,633,000 and $8,945,000 while the Department of Commerce will maintain level funding.

The FAA has a program to improve service to the aviation community by increasing the number of facilities that make weather observations and by installing additional meteorological equipment. $1,000,000 is planned for procuring and installing hygrothermometers, cloud height indicators, as well as runway visual range and wind equipment. Installation is expected at 15 sites per month over a two-year period. New radio equipment for continuous transcribed weather broadcasts will be procured and installed at 40 locations for $650,000. The FAA, in cooperation with NOAA, is conducting tests of telephone recorded quadrant route forecasts for preflight briefings at Washington, D.C., and New York City. The service will be extended to other areas if the tests are successful. The FAA's en route advisory service now in operation at four locations along the west coast is designed to enhance the safety of flight operations. An increase of $2,913,000 is planned for equipment and services to expand en route flight advisory service and to provide for more pilot briefings.

In the Department of Defense the Navy plans for an increase of $664,000 supplemented by funds available through decreases in other programs. These increases include two replacement radars for Keflavik, Iceland, and the Naval Aviation Technical Training Center, Lakehurst, N.J., and 65 automatic weather stations (25 shipboard and 40 land) at a cost of $960,000; procurement of ten Naval Environmental Display Stations for automated processing, storing, retrieving, and displaying of meteorological and oceanographic information with two each at the Fleet Numerical Weather Central in Monterey and four Fleet Weather Centrals (Guam, Pearl Harbor, Norfolk, and Rota, Spain) at a cost of $320,000 attributed to aviation services; and increases amounting to about $200,000 to include maintenance, facsimile costs, and internal support. Other Department of Defense increases planned for expansions in the capability for processing satellite data will improve both Air Force and Navy support to the aviation service.

Of the Air Force planned increases, $8,300,000 is attributed to the Aviation Meteorological Service. Major items include six weather radars for tactical weather systems, satellite equipment and operations, emergency power systems, computer upgrading, and increased costs for personnel, training, and supplies.

The remainder of the planned increases by the Department of Defense for FY 1976 involves mainly the impact of inflation and its effect upon operational costs.

Research Program for Fiscal Year 1976

For supporting research, the Department of Transportation is planning an increase of $522,000, while the Departments of Commerce and Defense will maintain level funding.

The aviation meteorological research program of the Department of Transportation's Federal Aviation

Administration (FAA) is designed to provide the technical and operational developments that will improve performance and use of existing components of weather acquisition, distribution, processing, and display equipment. The objective is to modify these specific components for integration into the modernized configuration of the National Airspace System.

The FAA will conduct a sustained engineering effort to improve measurement and display techniques for cloud height, altimeter setting, and visibility.

The assessment and reporting of slant visual range and the development of new methods for reporting runway visual range values under 600 ft. are being investigated. An acoustic sounder, utilizing Doppler techniques, is being evaluated as a means of reporting wind shear and other low-level wind measurements. The development and specification of a Semi-Automated Weather Reporting System providing digital readouts of wind direction, speed, gusts, altimeter setting indicator, temperature, and dewpoint based upon a National Weather Service automatic weather station is nearing completion. An aviation automated weather observation system is presently under development by the National Weather Service under FAA direction and funding to provide the above functions plus others, including visibility, cloud height, cloud cover, and present weather.

In addition, the FAA is monitoring the development of techniques for detecting and predicting clear air turbulence. NOAA, under contract with the FAA, is continuing work on improving the accuracy, timeliness and reliability of aviation weather forecasts in the 0-4 hour time frame.

Continuing research by NOAA will be directed toward automated methods for improving observations of visibility, cloud cover and height, and occurrence of weather such as freezing rain, hail, and thunderstorms. An infrared cloud measurement system has been developed by the Department of Commerce. During FY 1976, data from this system will be collected and evaluated to assess its usefulness as a new cloud observational technique.

Under the program for automation of field operations and services, automated techniques for generating aviation terminal forecast guidance and for monitoring terminal forecasts will be tested in the model facility at the National Weather Service Headquarters.

Department of Defense research efforts are oriented toward specific military requirements and are described in the General Military Meteorological Service section. In general, those aspects related to military aviation services include the application of data gathered from a small-scale network to improvements in short-period terminal forecasts; continued development of techniques for dissipating fog at airfields; and the design of instruments and techniques to support land and sea-based aviation operations.

MARINE METEOROLOGICAL SERVICE

Description

The Departments of Commerce, Transportation, and Defense share statutory responsibility for the Marine Meteorological Service, designed to promote the efficiency of the civil and military marine operations and to insure the safety of life and property at sea and on coastal and inland waters. Many segments of the economy--including transoceanic, coastal, and Great Lakes shipping, commercial fishing, offshore drilling and mining, deep port activities, and recreational boating--need detailed forecasts of winds, sea and swell, surf and breakers, ice conditions, anomalous water levels, sea surface temperature, and ocean current regimes.

- The Department of Commerce is responsible for collecting observations, issuing forecasts and warnings, and disseminating marine meteorological information to benefit marine industry, navigation, sport fishing, and the general boating public.
- The U.S. Coast Guard, because of its many missions such as search and rescue, and as lead agency for the reporting and monitoring of discharges of hazardous substances and oil spills and their amelioration, has a unique capability to cooperate with the Department of Commerce by making weather observations and disseminating weather warnings and forecasts on the high seas and waters over which the United States has jurisdiction.
- The Department of Defense is responsible for providing marine meteorological information to its forces as well as for cooperatively providing ship and coastal observational data to other agencies for marine services use.

Marine meteorological observations include those from the cooperative merchant ship program, the tide and wave gage network, environmental data buoys, satellites, and from about 200 cooperative marine reporting stations along the U.S. coastline. Most of the latter are Coast Guard stations that provide 2-, 3-, and 6-hourly observations of at least present weather, wind, and state of the sea.

Environmental data buoys, funded by the National Oceanic and Atmospheric Administration (NOAA), are used to obtain observations from areas adjacent to the U.S. coast. The U.S. Coast Guard, through a cooperative agreement with NOAA, places the buoys on station and removes them for overhaul and maintenance purposes. There is a need for improving buoy components that can withstand the severe ocean environment.

While at sea, major commissioned vessels of the Navy and large Coast Guard cutters make weather reports that supplement observations largely supplied by the Basic Meteorological Service. Twenty-six naval vessels have sophisticated equipment for detailed surface observations, with 22 of these equipped to make upper air observations. Twenty-three Coast Guard cutters are also equipped with balloon inflation shelters for making upper air observations. These observations are made available to other Federal agencies through routine data collection and exchange. The Navy has a need for improvement in data handling, for meteorological personnel on more ships, and for better marine forecast techniques.

The Department of Commerce supplements the analysis and forecasting functions of the Basic Meteorological Service with specialized marine support operations at a number of its Weather Service Forecast Offices (WSFO). The Marine Forecast Unit at WSFO Anchorage, Alaska, provides marine support in Alaskan waters, including the Gulf of Alaska and the Bering, Chukchi, and Beaufort Seas. Particular attention is given to sea ice and its effect on shipping and drilling. The Marine Forecast Unit at WSFO San Francisco operates an expanded marine environmental service program in cooperation with the Coast Guard. Weather and sea forecasts and warnings are provided 8 hours a day by radiofacsimile, voice, and Morse telegraphy from the Coast Guard radio station at Point Reyes, Calif. Marine forecast units at WSFOs Honolulu, San Francisco, Anchorage, Washington, and Miami provide high seas marine services for the North Pacific, Gulf of Alaska and Bering Seas, and the western North Atlantic. WSFO Honolulu also provides services as needed for part of the South Pacific. Within these areas the United States is responsible for shipping forecasts and warnings under the Safety of Life and Sea Conventions and the World Meteorological Organization. In the extreme western North Pacific, the Department of Defense provides those services.

In other areas, such as coastal and offshore waters, marine forecasts and warnings are issued by 19 WSFOs. The Great Lakes weather and ice service program, provided by 5 WSFOs, is being substantially aided by resources of the Great Lakes and St. Lawrence Seaway Navigation Season Extension Demonstration Program, which is managed by the Department of Defense's Corps of Engineers. Twenty-eight other WSFOs serve recreational boaters for lakes and waterways within their area of responsibility as part of the public forecast program.

Four Fleet Weather Centrals supplement the broadscale products from the Navy's Fleet Numerical Weather Central (FNWC) and NOAA's National Meteorological Center by preparing detailed analyses, forecasts, and warnings for their assigned areas of responsibility. In addition, FNWC and one of the Fleet Weather Centrals provide optimum-track ship routing services to naval vessels and commercial ships operating under Department of Defense contract. These facilities need automated techniques for improving the ability to process, store, and display meteorological and oceanographic data.

Dissemination channels provided by the Department of Commerce for weather information and warnings in coastal areas and the Great Lakes include NOAA Weather Radio broadcasts, messages over the NOAA Weather Wire Service, and recorded telephone forecasts.

A special service for high-seas shipping is provided by NOAA in cooperation with the National Bureau of Standards, using the time-signal broadcast facilities of WWV (Colorado) and WWVH (Hawaii). It consists of three brief 45-second broadcasts each hour, giving information on major storms in the North Atlantic and the North and South Pacific. Facsimile service from Coast Guard and Department of Defense radio broadcasts is available to specially equipped ships. All Department of Defense naval broadcasts--radio-teletypewriter, voice, and facsimile--primarily support naval forces and are subject to change in schedule and content on short notice.

Table 7.--Marine Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
Commerce	1,977	1,977	125	150	2,102	2,127
Defense:						
Navy	6,731	7,413	1,224	1,318	7,955	8,731
Transportation:						
Coast Guard	439	467	.....	.....	439	467
Total	9,147	9,857	1,349	1,468	10,496	11,325

Marine users rely on the various communications systems or on the Coastal Warning System for their information. The latter system is a cooperative network of about 400 visual (flag and light) signals at prominent locations along the coasts, Great Lakes, and inland waterways to advise marine interests when warnings are in effect. The U.S. Coast Guard and NOAA operate about one-half of these displays. Non-Federal interests operate the remainder. This system is being phased out in favor of the NOAA Weather Radio continuous weather broadcast system which offers more up-to-date information. More than 100 Department of Defense weather offices at shore stations and aboard larger ships provide marine briefing services in support of naval operations.

Table 7 lists the costs of the Marine Meteorological Service, by agency, for FY 1975 and FY 1976.

Operational Program for Fiscal Year 1976

The Department of Defense plans an increase of $682,000 in FY 1976 while Department of Commerce and Coast Guard funding for Marine Meteorological Service operations will remain essentially level.

The Department of Defense (Navy) will add meteorological personnel to three major ships bringing the total to 29 vessels that can make complete weather reports and forecasts. In addition, $320,000 of the $800,000 planned for purchase of Naval Environmental Display Stations to be installed at the Fleet Numerical and four Fleet Weather Centrals is attributed to the Marine Meteorological Service.

The Department of Commerce is cooperating with and supporting, primarily through the Maritime Administration, the Sea Use Marine Services Development Group established in Seattle, Wash., and collocated with the WSFO at Seattle. This group works with several companies and Federal agencies interested in improving marine advisories and optimum ship routing in the Northeast Pacific Ocean and the Gulf of Alaska.

Research Program for Fiscal Year 1976

The Department of Commerce and Navy will continue marine services research at nearly level funding through FY 1976.

The Department of Commerce is continuing to emphasize development of automated techniques for producing marine observations and forecasts for oceanic and coastal areas and the Great Lakes. In the observational area, the development of the automated Shipboard Environmental Data Acquisition System is needed to ensure receipt of marine observations on a continuing basis for use in the preparation of marine forecasts and advisories. Forecast improvement efforts related to new and better techniques for predicting wave heights and storm surges along coast lines are planned.

Research, development, test, and evaluation will continue on buoy components and systems that can withstand the severe ocean environment. The buoy program of about $7 million in base funding is described and accounted for in the *Federal Plan for Marine Environmental Prediction*. This plan includes studies on air-sea interaction and the coupling of ocean-atmospheric processes.

The Navy is continuing research on marine fog, haze, thunderstorms and other small-scale hazards to marine operations through field experiments, laboratory studies and numerical modeling. The Department of Defense is developing analysis and prediction models and techniques for providing a global, automated prediction system. The system would collect, process, disseminate, and display environmental information for use in problems unique to military operations on a near real-time basis.

SPACE OPERATIONS METEOROLOGICAL SERVICE

Description

The Space Operations Meteorological Service provides the specialized weather information required to plan and conduct the Nation's space and missile programs. Both the National Aeronautics and Space Administration (NASA) and the Department of Defense require weather support for their programs.

NASA relies heavily on the Department of Commerce through several reimbursable agreements for providing forecasting and staff support services for the:

- Manned space flights and related programs of the J.F. Kennedy Space Center and the Johnson Space Center
- Earth-sensing unmanned satellites in the LANDSAT (earth resources technology satellite) and GEOS-C (Geodetic Earth Orbiting Satellite-C) programs
- Varied programs of the Wallops Flight Center.

The manned flights require forecasts for planned and possible emergency landing areas in many parts of the world. The earth-sensing efforts on both manned and unmanned flights need nearly global weather surveillance and forecasts. Weather satellite products are especially valuable in making such forecasts. Department of Commerce support to global space operations is provided from the World Weather Building at Camp Springs, Md. This arrangement allows for ready access to both weather analysis and forecast information and satellite data.

The wide range of observations required at the Kennedy Space Center is provided primarily by Department of Defense's Air Force Eastern Test Range which extends southeastward into the Atlantic Ocean. Improved instrumentation to support the specialized nature of this service is needed. As an example, measurements of atmospheric electricity are important to the prediction of lightning which can affect satellites in a launch configuration. The Air Force provides the forecasting service for NASA's unmanned launches at this center as well.

The Department of Defense also supports the Space Operations Meteorological Service for the:

- Space and Missile Test Center at Vandenberg AFB
- Pacific Missile Range which includes Pt. Mugu, San Nicolas Island, and Barking Sands, Hawaii.

Due to recently imposed manpower restrictions, the National Oceanic and Atmospheric Administration (NOAA) will no longer be able to provide personnel at San Nicolas Island and Barking Sands on a reimbursable basis with the Department of Defense. These personnel will be phased out by June 30, 1975. Department of Defense actions are underway to continue this support by replacing NOAA staffs with civilian and/or military personnel.

Surface, rawinsonde, and weather radar stations located on islands and ships support the Atlantic and Pacific ranges. Specialized staffs at range stations provide weather forecasts and planning studies. Observations for Department of Defense space activities are taken, partly by Department of Defense personnel and partly through contracts with private industry. The observations are needed to determine the conditions that missiles and space vehicles will encounter either at launch or upon reentry into the atmosphere.

The Department of Defense range stations and the NASA Wallops Flight Center participate in the Cooperative Meteorological Rocketsonde Network through which atmospheric measurements above 30 kilometers are collected to support missile operations, space exploration, and atmospheric research.

Meteorological support is also provided to the White Sands Missile Range, N.Mex., to the Kwajalein Missile Range, and to other Department of Defense research and test facilities. The Army needs to increase its meteorological support to research activities at test sites and for the White Sands Missile Range.

In both NASA and Department of Defense programs, weather observations from local, national, and international networks are used along with weather radar, satellite, and aircraft reconnaissance data as a basis for forecasts and warnings of weather that might affect launch or recovery areas.

Table 8 lists the costs of the Space Operations

Table 8.--Space Operations Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
Defense:						
Navy	770	895	.....	.....	770	895
Air Force	6,536	7,081	.....	.....	6,536	7,081
NASA	1,128	1,365	108	110	1,236	1,475
Total	8,434	9,341	108	110	8,542	9,451

Meteorological Service by agency for FY 1975 and FY 1976.

Operational Program for Fiscal Year 1976

The Department of Defense and NASA plan increases of $670,000 and $237,000, respectively. For the most part, these increases will cover added operational costs and will allow continuation of service at about the same level of effort.

Research Program for Fiscal Year 1976

No significant funding is being planned for specific research for the Space Operations Meteorological Service. However, as part of the General Military Meteorological Service, a continuing program for improved meteorological instrumentation will meet the needs of the test ranges. This instrumentation and data will be used to assist in scheduled launch operations, evaluating missile and payload flight performance, making reentry calculations, and insuring range safety. As part of the General Military Meteorological Service supporting research program, Defense is planning to improve rockets and rocketborne instruments and is investigating upper atmospheric phenomena through use of rocket data. This research will be directed toward a number of activities supporting Army test sites and the White Sands Missile Range.

The NOAA teams supporting the NASA manned space programs conduct a variety of studies oriented toward mission planning and toward development of forecasting techniques for future flights. Much of their current efforts concerns weather support plans for Space Shuttle operations.

AGRICULTURE METEOROLOGICAL SERVICE

Description

With the new awareness of increasing pressures on global food resources, the role of this service is becoming more vital to the promotion of the Nation's welfare and economy. The Department of Commerce and Agriculture cooperatively share responsibility for providing the Agriculture Meteorological Service. The service includes specialized observations, forecasts, advisories, warnings, assessments of the impact of weather and climate upon agricultural production, and supporting research directed toward the needs of agricultural interests.

The Department of Commerce has the responsibility for planning and conducting the service while the Department of Agriculture carries out supporting research, assists in planning, and cooperates in observing, communicating, and distributing weather information.

Specialized observation networks are maintained in agricultural areas away from the normal observing sites in or near urban areas. In most cases, observations are made on a cooperative basis between the Department of Commerce and other Federal and State agencies or private interests. Thousands of private citizens serving without pay provide daily measurements of air and soil temperatures, rainfall, and evaporation in crop areas. Observers for Federal and State agencies at agricultural experiment stations, colleges and universities obtain detailed small-scale meteorological data for studying agriculture-weather relationships.

Forecasts for agricultural users--ranging from a

short-period forecast which affects planting, harvesting, crop dusting, and spraying to a 30-day outlook for general agricultural planning--are prepared at National Oceanic and Atmospheric Administration (NOAA) Weather Service Forecast Offices in each of the 12 agricultural service areas (see Fig. 9). Interpretive and extension services are provided by advisory agricultural meteorologists from 10 Weather Service Offices (Agriculture) and two Environmental Study Service Centers at Federal and State experiment stations. A service for wool growers and livestock producers in Wyoming and North and South Dakota makes recorded forecasts and warnings continuously available by telephone from mid-October to mid-May. Similar weather services for fruit and vegetable growers are available in New Jersey and Michigan.

A special fruit-frost service is concentrated in the western states, Wisconsin, and Florida. This service has been integrated into the Agricultural Meteorological Service in western lower Michigan, the lower Rio Grande Valley, New Jersey, Utah, and in West Virginia. Warnings of low temperatures for specific temperature stations along with an outlook for the next three to five nights; an advisory service to growers on how to prevent frost and freezing temperature damages; annual reports on the general character of each season with respect to crop-weather relationships; temperature surveys in agricultural areas; and studies of temperature and crop relationships are provided.

Agricultural forecasts, warnings, and advisories are disseminated directly to users and to the mass media over the NOAA Weather Wire Service.

The Department of Commerce, in cooperation with the Department of Agriculture, participates in publishing the "Weekly Weather and Crop Bulletin." This publication includes crop condition reports

Figure 9.—NOAA Agricultural Meteorological Service.

along with national and world-wide crop summaries and has about 3,000 subscribers across the country. Last year's unfavorable weather in the northern plains and mid-west reduced wheat, corn, and soybean crops and emphasized the importance of current and reliable weather information for agriculture.

The large area crop inventory experiment represents a coordinated effort among the Departments of Commerce and Agriculture and the National Aeronautics and Space Administration concerned with assessing world-wide wheat production. As part of this experiment the Department of Commerce established the new Center for Climatic and Environmental Assessment to develop statistical models for estimating crop yields. This Center will furnish yield factors needed for assessment of wheat production in regions of the United States and other selected areas and will also furnish statistical risk assessments of climatic patterns. This activity will focus attention upon the impact of weather and climate on crop yields.

In an effort to further improve the Agriculture Meteorological Service, existing resources are being concentrated into new facilities designated as Environmental Study Service Centers. The first was established at Auburn, Ala., to serve the States of Alabama, Georgia, and Florida, and the second serves the States of Arkansas, Louisiana, Tennessee, and Mississippi from a location at Stoneville, Miss.

The Centers provide:

- Agricultural weather summaries and advisories
- Technical studies relating weather to agriculture
- Consulting services for agricultural research efforts
- Liaison services with agricultural organizations and users.

Wheat harvesting in the mid-west.

A further effort to improve this service has been made through agreements between NOAA and the States of Nebraska, North Dakota and South Dakota. These agreements provide for daily exchanges of information between the respective Weather Service Forecast Offices and the State Agriculture Extension Services. The state agencies incorporate meteorological information into a summary of the weather impact on farm operations and disseminate the summary on the NOAA Weather Wire Service.

The agricultural meteorological service is not yet fully available for all major crop belts. As a result, there is a need for improving organizational support for this service. In addition, a need exists for continuing research in such areas as weather-crop relationships and the effect of climate on crops and insects.

Table 9 lists the costs of the Agriculture Meteorological Service, by agency, for FY 1975 and FY 1976. A change has been made in this table as forestry meteorology research conducted by the Department of Agriculture will now be included as part of the Forestry Meteorological Service.

Operational Program for Fiscal Year 1976

The Department of Commerce will maintain level funding of $2,394,000 for FY 1976. A plan is being prepared to implement the Environmental Study Service Center concept at nine additional locations. This concept will improve agricultural services by concentrating present advisory resources into centers with greater potential for satisfying a wide range of agriculture user needs. Plans are being drawn to expand the activities of the Center for Climatic and Environmental Assessment to provide a focus for analysis and modeling of large-scale weather effects upon crop production. In addition, the planned expansion of the NOAA Weather Wire Service and NOAA Weather Radio described under the Basic Meteorological Service will allow for more effective dissemination of agricultural forecast, warning, and advisory products.

Research Program for Fiscal Year 1976

The Department of Agriculture funds supporting research for this service. Essentially level funding of $892,000 will allow continuation of on-going efforts. Studies are being conducted on the effect of climatic factors on various insect species, including their development and behavior, and on better uses for beneficial species. Basic studies are being conducted to determine the relationship between climate and such factors as crop hardiness, quality, productiveness and drought resistance; and methods are being developed for the establishment of windbreaks and for the determination of their effect on air, soil, water, and snow movement. The Department is directing a national research program on plant disease epidemiology and forecasting in which extensive use is made of micrometeorological data observed at the plant level. Studies are being performed to determine the action of air pollutants on plants, on methods for controlling such damage and on the effects of hail upon crop production.

GENERAL MILITARY METEOROLOGICAL SERVICE

Description

The Department of Defense requires world-wide meteorological services to support specific military operational and planning activities. The General

Table 9.--Agriculture Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
Agriculture	.....	.....	876	892	876	892
Commerce	2,394	2,394	.....	.....	2,394	2,394
Total	2,394	2,394	876	892	3,270	3,286

Military Meteorological Service provides military users with support not available from the Basic Meteorological Service or from other Specialized Meteorological Services. Support for explicit users, such as aviation, marine, and space operations, is covered in the sections on the relevant Specialized Meteorological Services.

Military user groups require meteorological information directed to the needs of:

- Weapon systems being developed or employed
- Command and control systems
- Army and Naval firing units
- Research, development, test, and evaluation
- Training and deployment of military forces
- Contingency operations.

To provide these special meteorological services, The Department of Defense maintains analysis and forecasting facilities in the United States and abroad. These include the Air Force Global Weather Central at Offutt AFB, Nebr., the Fleet Numerical Weather Central at Monterey, Calif., plus forecast centers and tactical forecast units in Europe, the Pacific, and the Far East. Specialized centers--such as the Air Force Environmental Technical Applications Center at Scott AFB, Ill., and the Joint Typhoon Warning Center at Guam--also fulfill unique military meteorological requirements. Similarly, Department of Defense observation facilities are operated to obtain data in direct support of military operations. Military communications networks are maintained to collect and exchange observations and to disseminate forecasts. Whenever possible, these observations are made available to other Federal agencies.

Aerial weather reconnaissance plays a vital role in specific Department of Defense operations. Essential weather observations from tropical cyclone penetrations, refueling and enroute weather observations for tactical deployments and contingency exercises, and weather observations for missile recovery areas are the types of information obtained from aircraft reconnaissance. The Defense Meteorological Satellite Program provides unique meteorological data with maximum responsiveness to military decision makers.

In support of tactical operations, Department of Defense has developed a series of air-transportable van complexes and is capable of deploying mobile tactical weather stations, radiosonde teams, and weather radars. There is a need for radars to be added to some of these units to achieve the capability of providing complete meteorological support to deployed forces. Other major Department of Defense improvements needed to meet military operational requirements include computer upgradings and expanded satellite data processing capability. Research needs involve mainly small-scale meteorological studies, investigations of atmospheric properties and supporting equipment.

Table 10 lists the costs of the General Military Meteorological Service for FY 1975 and FY 1976.

Operational Program for Fiscal Year 1976

The Department of Defense is planning to increase spending for General Military Meteorological Service operations by $5,252,000 in FY 1976. The Navy's share of this increase includes $2,800,000 to procure computer equipment for satellite data processing, $400,000 for supporting high speed communications, and $160,000 of the $800,000

Table 10.--General Military Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
Defense:						
Army	5,786	5,496	11,571	11,932	17,357	17,428
Navy	6,537	10,174	1,779	2,596	8,316	12,770
Air Force	22,877	24,782	6,894	7,418	29,771	32,200
Total	35,200	40,452	20,244	21,946	55,444	62,398

Forecaster module of air-transportable van for Air Weather Service support of tactical operations.

Artist's conception of Naval Environmental Display Station.

required for the procurement of the Naval Environmental Display Stations previously described under the Aviation and Marine Meteorological Services.

The Air Force plans an increase of $1,900,000 in operations to improve the General Military Meteorological Service. In part, these funds will provide emergency power back-up at the Air Force Global Weather Central, upgrading of an 1108 computer to an 1110, the purchase of six radars for weather support to deployed forces, and equipment for meteorological satellite operations.

Research Program for Fiscal Year 1976

Military research program increases planned for FY 1976 will amount to $1,702,000. Some of the Department's research programs have been categorized and discussed under previous subsections of the Plan as research directed toward improvements in a specific Service. These are also considered as research in support of the General Military Meteorological Service because they are directed toward improvements in meteorological support to the overall Department of Defense mission.

Army research in atmospheric sciences is directed toward increasing the effectiveness of weapons systems and the conducting of field operations. To obtain information on atmospheric effects produced by nuclear bursts, the chemical and electrical composition of the upper atmosphere will be sampled and measured using balloon-borne instruments first in mid-latitudes and later in the polar region. Complementing this effort will be extensive measurements of density, temperature, pressure, and upper winds.

To provide information on the properties of the atmosphere within the theoretical areas of combat, experiments are being performed at Army research centers using balloon and airborne instruments, and an automated small-scale network of observation stations. Data will be used in validating models of atmosphere processes.

The current Army research program in remote sensing is principally concerned with using lasers to demonstrate the feasibility of near real–time wind profiles for correcting artillery and rocket firing. The effectiveness of Army operations and systems is limited, not only by meteorological conditions, but also by atmospheric gases and dust. To assess this limitation, the absorptive properties of atmospheric gases will be measured under varying conditions. Atmospheric dust samples from selected locations will be analyzed to determine variations of the visible and near-infrared absorption coefficients.

Development of an atmospheric sounding system is continuing with the objective of improving artillery's first-round hit accuracy. Research will be continued on model development and software for an automated system designed to supply near real-time meteorological data for artillery fire, airmobile and Army aviation, chemical and nuclear defense, and other tactical operations.

The Navy will continue laboratory and field experiments in its marine fog investigations to study cloud and fog composition and processes with the objective of eventually having a weather modification capability. With the view toward achieving maximum use of environmental satellite sensor output required to support naval operations, radiometers will be tested to develop a capability to measure portions of the oceanic and atmospheric environment from airborne and spaceborne platforms. Sea tests and evaluation of a communication satellite relay system will be completed. This system is intended for transmission of environmental data to ships at sea that do not have environmental satellite readout equipment. New techniques will be developed including numerical models for analysis and prediction of atmospheric conditions, air-sea interaction effects, and weather.

The Air Force research programs in meteorology reflect funding for system support which had not been included previously. The support consists of task force members who define environmental parameters and adapt the results to specific weapon systems. The support program will exploit the technologies of cloud physics, instrumentation, weather radar, applied climatology, and satellite meteorology; the work takes a system approach and is not done elsewhere in the meteorological community.

FORESTRY METEOROLOGICAL SERVICE

Description

Federal, State, and local agencies charged with protection and maintenance of the Nation's forests depend on reliable meteorological data and forecasts provided by the Department of Commerce. A specialized national plan is being developed which describes in more detail the services available to forestry interests.

On-going forest fires require precise forecasts for use in fire control.

Table 11.--Forestry Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
Agriculture	.....	.....	465	495	465	495
Commerce	1,812	1,812	.....	.....	1,812	1,812
Total	1,812	1,812	465	495	2,277	2,307

The Forest Service of the Department of Agriculture and the Bureau of Land Management of the Department of Interior, along with state forest agencies contribute to the Fire Weather Service by supplying fire weather observations for some 2,000 locations scattered through state and national forests. The Forest Service also conducts forestry research which supports this service.

Within the framework of broad-scale guidance produced by the National Meteorological Center, specialized forecasts and warnings for use by fire control agencies are provided by 52 selected weather offices of the National Weather Service. These Weather Service Forecast and Weather Service Offices are responsible for specialized forecast, advisory, and warning services to forestry and rangeland fire control interests. These services include five-day outlooks, 36- to 48-hour general forecasts of winds, temperature, rainfall, humidity, and fuel moisture on a twice per day basis in most areas during the forest fire season. Forecasts are issued, as required, during a fire.

Twenty-three camper-type mobile units, manned by fire weather meteorologists, are available in the western United States for dispatch to major forest fires. Contact with the home station is maintained by two-way radio and radio facsimile for relay of appropriate meteorological data. Through this means, fire control interests receive immediate forecasts and advisories from the unit on the scene of action.

The National Oceanic and Atmospheric Administration (NOAA) also supports smoke management programs for control of prescribed burning operations for the removal of forestry and agricultural wastes. Forecasts are issued to help State and Federal authorities in determining when, where, and how much debris to burn without degrading the air quality.

Weather has some pronounced effects on our Nation's forests. For example, long periods of dryness make the forests and undergrowth susceptible to fire. Lightning strikes from thunderstorms can trigger a fire at any time. Winds accelerate the drying of forest land and increase the spreading of a fire. On the other hand, precipitation may retard the spread of a forest fire. Forest Service research efforts need to be continued to improve our understanding of forest and mountain meteorology.

Table 11 lists the costs of the Forestry Meteorological Service, by agency, for FY 1975 and FY 1976. This table now includes forestry research previously shown as part of the Agriculture Meteorological Service.

Operational Program for Fiscal Year 1976

The Department of Commerce will maintain level funding in the Forestry Meteorological Service. The expected expansion in the NOAA Weather Wire Service and the NOAA Weather Radio described under the Basic Meteorological Service will help in disseminating the specialized Forestry Meteorological Service products to the appropriate users.

Research Program for Fiscal Year 1976

Department of Agriculture plans call for a $30,000 increase in research funding. Major areas of interest include meteorological aspects as they relate to controlled burning of forest wastes, the influence of weather on forest fire behavior, and better understanding of the effects of weather on forest conditions.

AIR QUALITY METEOROLOGICAL SERVICE

Description

Over 70 percent of the Nation's population is concentrated in some 200 urban areas with less than

10 percent of the country's land area. Solution of the continuing air pollution problem associated with urbanization demands the coordinated efforts of Federal, State, and local government. The Department of Commerce's National Weather Service provides essential meteorological data and forecasts to Federal, State, and local governmental agencies responsible for dealing with urban air pollution and advises the public of weather conditions that may lead to serious air pollution episodes. The Environmental Protection Agency (EPA) conducts air quality research in support of the service.

The Department of Commerce's responsibilities include the surface and upper air observations necessary to describe the weather in urban areas, air stagnation forecasts in sufficient detail to provide the basis for air pollution control decisions, and applied research to improve these observations and forecasts. Fifty-two Weather Service Forecast Offices have the responsibility to prepare air stagnation advisories. Fourteen of these offices are staffed with specially trained air pollution meteorologists and six provide meteorological advisory service for smoke management. Each office prepares a daily dispersion outlook on the expected quality of the air. When pollution in the air becomes pronounced and is expected to persist for at least 36 hours, an air stagnation advisory is issued. Advisories are updated at least every 12 hours and re-issued in 24 hours. For additional observations within urbanized areas, nine cities have low-level sounding stations that provide vertical profiles of temperature, relative humidity, and winds to 10,000 ft. above the station.

EPA is responsible for working with State and local government agencies to insure adequate meteorological support programs. Applied research is accomplished principally by NOAA personnel assigned to EPA's Meteorology Laboratory in North Carolina.

A specialized plan is being prepared which describes in more detail the services available to Federal, State, and local agencies concerned with air quality.

Table 12 lists the costs of the Air Quality Meteorological Service, by agency, for FY 1975 and FY 1976.

Operational Program for Fiscal Year 1976

The Department of Commerce will maintain level funding in the Air Quality Meteorological Service. Increased emphasis on cross utilization of Weather Service Forecast Office forecasters, the continued automation of upper air sounding computations, and improvements in dissemination systems are designed to improve this Service along with the other Specialized Meteorological Services.

Research Program for Fiscal Year 1976

With respect to air quality, EPA plans no increases for research. Efforts will be focused on air quality simulation models to describe and evaluate the influence of air pollution on the environment and on studies of the long-range transport of pollutants, with particular attention to sulfates, nitrates, and ozone. The Regional Air Pollution Study in St. Louis will continue through FY 1976. The purpose of this study is to provide the necessary data base (air quality, pollutant emissions, meteorology) for the

Table 12.--Air Quality Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
EPA	.....	.....	8,430	8,430	8,430	8,430
NASA	.....	.....	50	50	50	50
Commerce	1,312	1,312	.....	.....	1,312	1,312
Total	1,312	1,312	8,480	8,480	9,792	9,792

Los Angeles, Calif., basin is frequently exposed to air pollution episodes.

development, evaluation, and validation of air quality simulation models on an urban scale.

OTHER SPECIALIZED METEOROLOGICAL SERVICES

Description

There are some Federal agencies and user groups who need specialized meteorological services, but their requirements are for services in support of research and development activities or for operations too small to warrant a separate service category. Additionally, the programs being supported are continuing efforts with little year-to-year changes. These include:

- Department of Defense programs for meteorological support to civil works projects and to some of its research, development, test, and evaluation activities such as equipment design and testing, geophysical laboratories support, and polar research operations.
- Energy Research and Development Administration programs for meteorological support to its laboratories and test sites.

Table 13.--Other Specialized Meteorological Service costs, by agency
(Thousands of dollars)

Agency	Operations		Supporting research		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
ERDA	1,965	2,198	462	479	2,427	2,677
Defense:						
Army	245	260	.....	.....	245	260
Navy	5,732	5,829	.....	.....	5,732	5,829
Air Force	8,171	8,851	.....	.....	8,171	8,851
Total	16,113	17,138	462	479	16,575	17,167

Table 13 lists the costs for the Other Specialized Meteorological Services, by agency, for FY 1975 and FY 1976.

Operational Program for Fiscal Year 1976

These specialized meteorological services support relatively stable programs and so little change is planned for FY 1976.

Research Program for Fiscal Year 1976

A small increase is planned for the Energy Research and Development Administration research program which includes support for the evaluation and prediction of atmospheric transport and diffusion and of atmospheric cleansing mechanisms such as deposition and washout. Supporting research for nuclear safety assessment includes studies of small-scale meteorological motions and dilution patterns predicted by a mathematical model and verified with tracer experiments over a variety of terrain features. Evaluation of safety aspects associated with the transport and storage of nuclear supply systems for space missions requires studies of the movement and composition of aerosol and gaseous radioactive materials extending from the earth's surface to orbital reentry altitudes.

Measurements and supporting studies are necessary for assessing the environmental impact of numerous other experiments. Data are collected to permit the assessment of the effect of meteorological variables on the relocation of aerosols. A broad variety of modeling is accomplished for application to studies of the long-range effects of various peaceful uses of nuclear power.

Operational Functions

INTRODUCTION

Five distinct functions--observations, analyses and forecasts, communications, dissemination to users, and general agency support--are common to all Basic and Specialized Meteorological Services. Each of these functions is described in this section of the Plan. Following each description are the program changes for FY 1976 as projected by the agencies to meet the Federal goals. Table 14 lists the agency operational costs, by function, and table 15 lists the agency manpower engaged in weather operations, by function, for FY 1975-76. Agency research programs are described in the Services section of this Plan and are not repeated here. However, table 16 lists the agency supporting research costs, by function, for FY 1975-76.

OBSERVATIONS

Description

Meteorological observations are of fundamental importance to all weather services. Five general categories of observations make up this basic function. They are:

- Surface observations of pressure, temperature, humidity, wind, clouds, precipitation, and visibility
- Upper air observations of pressure, temperature, humidity, and wind made by balloon, aircraft, or rocket
- Aircraft reconnaissance observations in which the upper air elements are measured at many points along a track at flight level. Pressure, temperature, and humidity are measured by dropsonde between flight level and the surface at a few points along the track
- Weather radar observations which detect the presence, motion, and intensity of storms in a volume of the atmosphere
- Meteorological satellite observations of cloud patterns and their motions, cloud-top temperatur s, and vertical temperature profiles of the atmosphere.

Table 17 shows the number of locations where each of the Federal agencies makes surface and vertical observations, together with the number of aircraft-years devoted to aircraft reconnaissance observations.

Table 14.--Agency operational costs, by function
(Thousands of dollars)

Agency	Observations		Analyses and forecasts		Communications		Dissemination to users		General agency support		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
ERDA	963	1,078	.....	.....	20	22	138	154	844	944	1,965	2,198
Commerce	91,494	98,169	69,863	70,929	8,736	8,736	30,966	48,141	42,302	42,302	243,361	268,277
Defense	81,698	88,772	29,236	34,500	22,385	24,081	31,847	32,679	48,358	51,408	213,524	231,440
NASA	200	278	542	498	94	75	74	86	218	428	1,128	1,365
Transportation:												
Coast Guard .	3,869	4,101	.....	.....	217	234	212	221	155	167	4,453	4,723
FAA	9,907	11,102	.....	.....	21,256	21,009	17,526	21,482	12,190	13,158	60,879	66,751
Total	188,131	203,500	99,641	105,927	52,708	54,157	80,763	102,763	104,067	108,407	525,310	574,754

Table 15.--Agency manpower engaged in weather operations, by function

Agency	Observations		Analyses and forecasts		Communications		Dissemination to users		General agency support		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
Commerce	1,667	1,656	2,070	2,084	151	151	1,091	1,130	1,452	1,458	6,431	6,479
(1)	51	51	20	20					34	34	105	105
Defense	2,232	2,293	1,049	1,067	783	778	2,164	2,122	1,697	1,707	7,925	7,967
(2)	363	364	678	679	244	245	301	302	1,570	1,721	3,156	3,311
(1)	5	5	8	8	2	2	2	2	9	9	26	26
NASA ..... (1)	.....	.....	1	1	.....	.....	.....	.....	2	2	3	3
Transportation:												
Coast Guard .	145	145	.....	.....	.....	.....	.....	.....	.....	.....	145	145
(2)	113	113	.....	.....	16	16	9	9	12	13	150	151
FAA ..... (2)	314	319	.....	.....	761	767	914	1,071	471	482	2,460	2,639
Total	4,890	4,946	3,826	3,859	1,957	1,959	4,481	4,636	5,247	5,426	20,401	20,826

(1) Personnel funded by other agencies.
(2) Man-years.

Table 16.-- Agency supporting research costs, by function
(Thousands of dollars)

Agency	Observation		Description		Prediction		Dissemination		Systems		Support		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
Agriculture	255	264	590	610	496	513	.....	.....	.....	.....	.....	.....	1,341	1,387
ERDA	231	239	185	192	46	48	.....	.....	.....	.....	.....	.....	462	479
Commerce	5,343	5,579	2,701	2,754	2,768	2,763	67	85	2,259	2,261	392	424	13,530	13,866
Defense	6,507	6,745	2,700	2,893	2,889	3,044	1,366	1,519	4,364	4,883	4,232	4,800	22,058	23,884
EPA	5,780	5,780	2,600	2,600	50	50	.....	.....	.....	.....	.....	.....	8,430	8,430
NASA	31,869	30,053	.....	.....	.....	.....	.....	.....	750	725	.....	.....	32,619	30,778
Transportation:														
FAA	1,541	1,416	.....	.....	20	15	3,189	4,715	3,302	2,428	.....	.....	8,052	8,574
Total	51,526	50,076	8,776	9,049	6,269	6,433	4,622	6,319	10,675	10,297	4,624	5,224	86,492	87,398

Table 17.--Number of locations by observation function, fiscal years 1975-76

Observation function	Agency	FY 75	FY 76
SURFACE (land)	Commerce[1]	562	587
	Defense	276	274
	Transportation (FAA)	348	348
	Transportation (Coast Guard)[2]	194	200
	NASA	3	3
	ERDA	9	9
SURFACE (marine)	Commerce (merchant ships cooperative program)	2,550	2,550
	Transportation (Coast Guard ships)	87	88
	Defense (ships with meteorological personnel)	26	29
	Commerce and Transportation (ocean stations)	1	1
UPPER AIR (rocket)	NASA (U.S.)	1	1
	NASA (overseas)	1	1
	Defense (U.S.)	3	3
	Defense (overseas)	2	2
	ERDA (U.S.)[3]	1	1
	ERDA (overseas)[3]	2	2
UPPER AIR (balloon)	Commerce (U.S.)	94	94
	Commerce (overseas)	33	33
	Defense (U.S.)	6	6
	Defense (overseas)	10	10
	Defense (ship)	22	22
	Defense (mobile)	11	11
	NASA (U.S.)	3	3
	ERDA (U.S.)[3]	3	3
	Transportation/Coast Guard)[4]	23	24
	Transportation/Commerce (OWS HOTEL)	1	1
WEATHER RADAR	Commerce (U.S.)	94	110
	Defense (U.S.)	91	93
	Defense (overseas)	24	22
	Transportation/Commerce (OWS HOTEL)	1	1
	NASA (U.S.)	1	1
WEATHER RECONNAISSANCE	Defense (No. of aircraft years)	24	20

[1]Cooperative stations operated by Departments of Agriculture, Interior, and Transportation, other public and private agencies, and those manned by volunteers are not included. Also excluded are 311 Supplementary Aviation Weather Reporting Stations and foreign cooperative stations.

[2]These Coast Guard land stations were formerly included under Surface (marine).

[3]Inactive but available for use.

[4]Balloon support facilities inactive, but available for use.

SURFACE OBSERVATIONS

Surface observations are taken by the Departments of Commerce, Defense, and Transportation, Energy Research and Development Administration (ERDA), and National Aeronautics and Space Administration (NASA) at about 1,400 land locations. These observations support basic analysis and forecasting functions and the specialized services. Observations are also taken for the National Oceanic and Atmospheric Administration by citizen volunteers and by employees of the Departments of Agriculture and Interior at some 13,000 cooperative stations. The volunteer stations support climatological needs and the stations of the Departments of Agriculture and Interior support agriculture and forestry needs.

Surface observations also are taken from ships at sea. More than 2,500 vessels of the merchant fleet provide cooperative observations in a program operated by Department of Commerce. The Department of Transportation's Coast Guard operates 87 ships and 194 shore and island stations. Ocean Weather Station HOTEL located off the east coast of the United States is operated by the Coast Guard with Department of Commerce providing the meteorological staff. Observations are also routinely provided by Department of Defense ships. At most of the marine stations, state of the sea is included in the surface observation.

Certain of the observing stations are designated as *benchmark* stations. They provide especially detailed observations to establish a reliable record for early detection of climatic fluctuations and trends. Additional dense networks of surface observing stations are established from time to time in support of small-scale meteorological research. Currently, the

The U.S. Coast Guard High Endurance Cutter HAMILTON provides surface weather observations while at sea and has an upper air balloon observation capability.

Department of Commerce operates such a network in the vicinity of Norman, Okla., in support of the National Severe Storms Laboratory. Other examples include the Environmental Protection Agency's network around St. Louis, Mo., in support of air pollution research and Department of Defense's network at the Air Force Cambridge Research Laboratories, Bedford, Mass., in support of small-scale meteorological research.

UPPER AIR OBSERVATIONS

Data from the upper air observing network provides the basic input to numerical analysis and forecasting. The Department of Commerce supports or operates 127 stations in the U.S. and overseas. The Department of Defense operates 38 fixed and shipboard stations, together with 11 mobile stations. The latter support special Department of Defense projects, but also are deployed (within assigned mission priorities and capabilities) to support other agencies research and development programs.

Upper air stations are operated by NASA (3 sites) and ERDA (3 sites) at test range and research facilities. These observations can be added to the basic network during severe weather alerts as provided by the *National Severe Local Storms Operations Plan*. Department of Commerce also makes special upper air soundings to three kilometers at nine locations in support of air pollution responsibilities of the Environmental Protection Agency. These soundings are too abbreviated to be of much use in large-scale analysis and forecasting, but are distributed over the Service C network for use in local forecasting, and especially for severe storm warnings.

NASA, ERDA, and the Department of Defense use rocketsondes to obtain temperature and wind measurements from altitudes above 30 kilometers at five U.S. and five overseas locations. These data support special high-altitude operations and contribute significantly to improving scientific knowledge of the outer atmosphere.

WEATHER RECONNAISSANCE OPERATIONS

The aircraft reconnaissance program of the Department of Defense provides valuable data from large areas of the oceans where island and ship observations are scarce. Precise information is obtained on the location, movement, and physical characteristics of tropical cyclones in the western Atlantic, Caribbean, Gulf of Mexico, and the Pacific as well as of winter storms off the east coast of the United States. Aircraft reconnaissance is requested only after a thorough evaluation of other data sources (satellites, radar, and ground stations) indicates that additional information from an aircraft mission is essential to the protection of U.S. lives and property. Procedures for initiating these reconnaissance flights are detailed annually in the *National Hurricane Operations Plan*, the *National East Coast Winter Storms Operations Plan*, and the *National Severe Local Storms Operations Plan*.

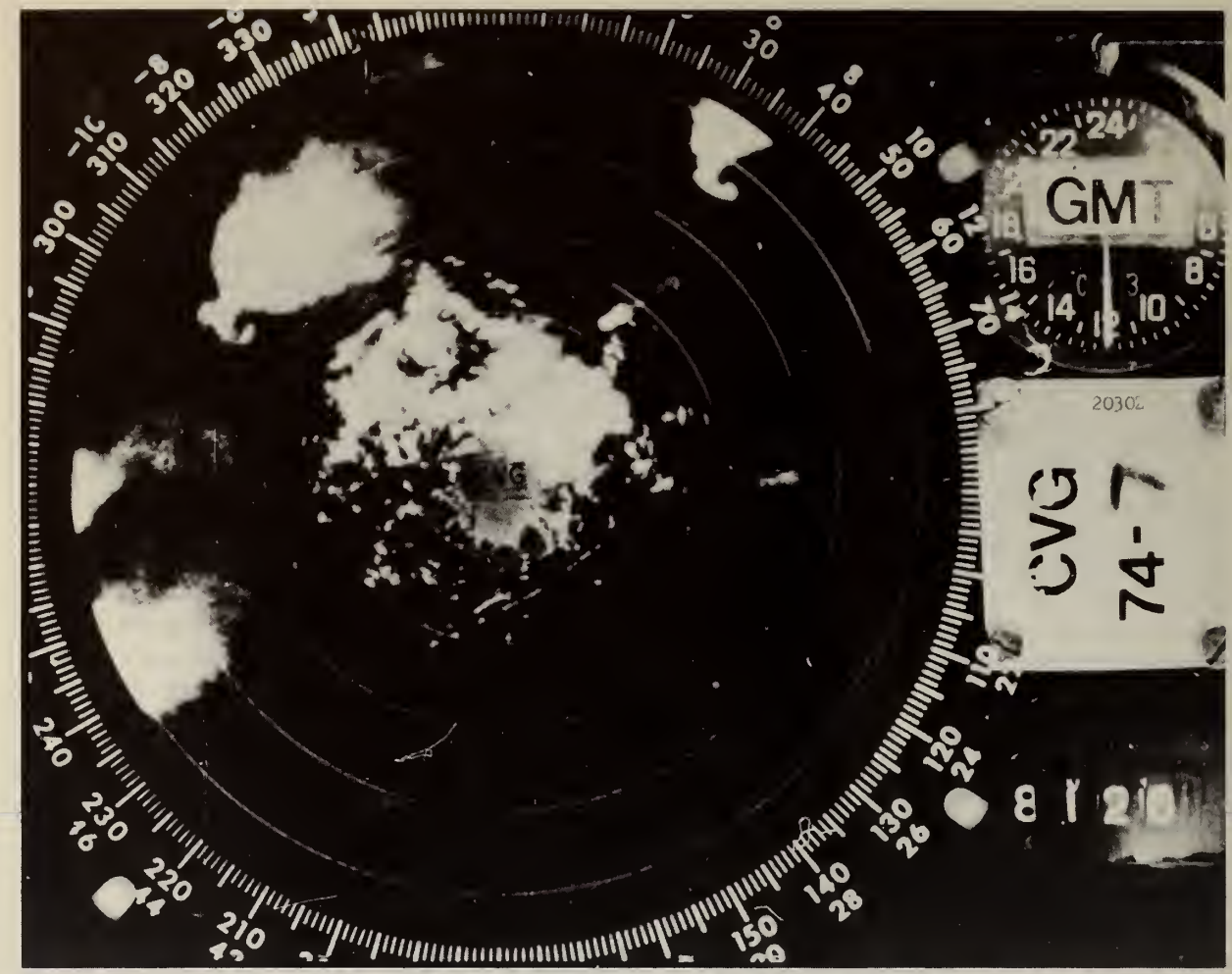
Nearly all aircraft reconnaissance is accomplished by the fleet of 20 Air Force WC-130s. Special flights also are conducted by the Air Force to support meteorological research programs. On some occasions aircraft of the National Oceanic and Atmospheric Administration's Research Facility Center perform reconnaissance in the North Atlantic, Caribbean, and Gulf of Mexico, but these aircraft are normally operated only for support of research programs.

WEATHER RADAR OBSERVATIONS

Radar is a principal source of weather information for making the short-term warnings of severe weather that contribute heavily to saving lives and property in many areas of the Nation. These radar observations provide:

- The best methods now available for the remote identification and tracking of squall lines, tornadoes, and other destructive storms
- A means for locating, tracking, and estimating the intensity of tropical cyclones as they approach the coast
- The information upon which estimates of precipitation rates and amounts can be based for use in flash-flood warnings and in managing water resources
- A means for detecting strong turbulence in convective storms.

Radar observations contribute to the basic meteorologica' service by measuring the intensity and motion of large areas of precipitation on the synoptic scale. In their role as detector and tracker of small-scale severe weather phenomena, radar observations must be passed rapidly in a communications network dedicated to reaching those who need to take quick action to avert a disaster.



WSR-57 radar at Cincinnati, Ohio. Hook echoes at 035° and 300° azimuth often indicate the likelihood of tornadoes. The hook echo at 035° is associated with the Xenia, Ohio, tornado of April 3, 1974.

The Federal Plan for Weather Radars identifies the needs for local warning and network weather radar observations and describes a coordinated long-term plan to meet those needs most economically. The Basic Weather Radar Network, established in the Plan to make detailed observations on a scheduled basis, uses Department of Commerce and certain Department of Defense radars. In the mountain states air traffic control radars of the Federal Aviation Administration are used to supply observations in regions where normal weather radar units would be very expensive to install and operate. Planned modification of the FAA radars to improve air traffic control will reduce the amount of weather data entering the Air Traffic Control Centers. As a result, Department of Commerce will need to procure equipment to obtain the weather data.

Observations from the weather radar network in the conterminous states are collected at the National Meteorological Center, compiled and sent over teletypewriter circuits. The National Severe Storms Forecast Center prepares graphical depictions sent over facsimile circuits for use in forecasts, warnings, and pilot briefings at civil and military weather service stations.

In the Department of Defense radar improvements are needed by both the Navy and the Air Force to provide weather support to deployed forces and for day-to-day operations.

METEOROLOGICAL SATELLITE OBSERVATIONS

Satellites provide an increasing amount of significant data for meteorological and oceanographic

analysis and forecasting, as well as information on severe weather. In addition to cloud images from the entire globe, the weather satellites of the Departments of Commerce and Defense provide temperature profile soundings which partially satisfy common requirements for upper air data over the remote ocean areas. NOAA 4, a polar-orbiting satellite with this capability, was launched in November 1974. SMS 1 and 2, NASA prototypes of the Geostationary Operational Environmental Satellite (GOES) series, provide near continuous high resolution surveillance of the birth and growth of hurricanes and major storms as well as of other weather events over the United States and the adjacent waters. Collection and relay of data from remote observing platforms, relay of centrally prepared facsimile products and upper-level winds derived from cloud-top motions are other features of this system.

The Defense Meteorological Satellite Program (DMSP) is an operational polar-orbiting system with the capability to obtain high-resolution meteorological data under low light level conditions. DMSP is managed by the Air Force and data are furnished to the National Oceanic and Atmospheric Administration for archiving and use by the international meteorological community.

Details of the meteorological satellite programs are covered in the Meteorological Satellite section of this Plan.

Program Changes for Fiscal Year 1976

Table 18 lists the total operational costs, by agency, for each of the observational types for FY 1975 and FY 1976. The Departments of Commerce and Defense and FAA have requested significant increases in their observational programs of $6,675,000, $7,074,000 and $1,195,000, respectively for FY 1976. Other agencies participating in the program plan only minor changes.

The major portion of Department of Commerce's planned increase is for procurement of long lead-time items for the next generation TIROS N polar-orbiting satellite at a cost of $5,430,000 (more details about this program are given in the Meteorological Satellites section). Another increase of $1,925,000 is planned for equipment to modify 22 FAA traffic control radars in the western United States to allow remote transmission of weather data to four Air Route Traffic Control Centers. Establishment of an upper air facility at Appalachicola, Fla., to replace a discontinued Department of Defense network observation at Eglin AFB, Fla., is also planned at a net cost of $43,000.

A decrease planned by Department of Commerce in FY 1976 amounts to $723,000 due to reductions in program management staff and the data buoy program.

Using $800,000 deferred in FY 1975, Department of Commerce would begin procurement of radar data processor/radar transmitter units for

Table 18.--Agency operational costs by type of observation
(Thousands of dollars)

Agency	Surface		Upper air (balloon)		Upper air (rocket)		Weather reconnaissance		Weather radar		Meteorological satellite		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
ERDA	337	377	.....	.....	626	701	.....	.....	.....	.....	.....	.....	963	1,078
Commerce	30,267	29,544	13,541	13,584	.....	.....	.....	.....	12,280	14,205	35,406	40,836	91,494	98,169
Defense	12,577	12,029	6,291	5,747	2,517	2,520	27,212	23,675	2,532	4,804	30,569	39,997	81,698	88,772
NASA	64	83	90	*145	46	50	.....	.....	.....	.....	.....	.....	200	278
Transportation:														
Coast Guard	3,482	3,691	387	410	.....	.....	.....	.....	.....	.....	.....	.....	3,869	4,101
FAA	9,904	11,102	.....	.....	.....	.....	.....	.....	3	.....	.....	.....	9,907	11,102
Total	56,631	56,826	20,309	19,886	3,189	3,271	27,212	23,675	14,815	19,009	65,975	80,833	188,131	203,500

*Includes 30K for National Space Technology Laboratory, Bay St. Louis, Miss., for Omega system.

installation on 56 network and 15 local warning radars. Base funding will be used to buy 18 satellite photo-recorders to complete equipment requirements for disseminating twice-hourly high resolution GOES data to Weather Service Forecast Offices for use in preparing forecasts and warnings. In addition, eleven recorders on hand will be installed while costs for operating 18 others now in place will be annualized.

In the Department of Defense the most significant FY 1976 increase for the Air Force is $7,896,000 for satellite equipment and operations. Other major increases include $1,160,000 planned for procurement of six self-contained tactical weather system radars and $803,000 for added aircraft reconnaissance operating costs. Offsetting these increases is a reduction of $994,000 due to reduced staffing in support of Western Test Range activities and reductions of capital outlay items such as lightning warning detectors and minicomputer procurements.

Air Force changes to its program for FY 1975 as shown in last year's Plan include an increase of $3,422,000 for manpower costs such as 44 additional personnel to increase hours of operation at critical locations. Other changes are $1,320,000 for developing a preproduction self-contained tactical weather station radar; $2,500,000 reprogrammed for Department of Defense satellite spacecraft items; $2,055,000 for relocating satellite readouts and depot support; and installation of a GOES readout capability at the Air Force Global Weather Central using $694,000 deferred from FY 1974.

In the Navy the significant change is deactivation of the weather reconnaissance squadron at Jacksonville, Fla., prior to July 1, 1975, which will reduce costs by $3,769,000 in FY 1976. Another reduction of $533,000 is due to less funds required to acquire GOES ground equipment. Other major changes include planned increases of $960,000 for procurement of two radars and 65 automated weather stations (25 shipboard plus 40 land) and $2,100,000 for purchase of two shipboard satellite readout terminals. The Army plans a $493,000 reduction in funds available for observations.

Modification to the FAA observational program for FY 1975 included a decrease of $1,478,000 due to reductions in procurement of cloud height indicators, hygrothermometers, runway visual range and wind equipment, and weather radar displays. This will be partially offset by a planned increase of $1,003,000 for FY 1976 to be applied to the same items except for the weather radar displays.

ANALYSES AND FORECASTS

Description

There are three major types of analysis and forecast centers and offices--primary, area and guidance, and specialized. Primary centers produce basic analyses and forecasts and provide basic warning services. Area and guidance centers and offices supplement the products of primary centers and adapt them to their particular regions. Specialized centers serve the unique requirements of specific user groups or provide a service not available from other centers, such as climatological support. Local offices issue short-period warnings and forecasts to the general public and are discussed in more detail in the Dissemination section.

The United States also participates in the international World Weather Watch program under the auspices of the World Meteorological Organization. Under this program, the National Meteorological Center, the National Environmental Satellite Service, and the National Climatic Center collectively form one of the World Meteorological Centers with global responsibilities for analyses and forecasts and for collection and retrieval of data. As another contribution to the international program, the Regional Center for Tropical Meteorology collocated with the National Hurricane Center in Miami has been designated by the World Meteorological Organization to be part of the World Weather Watch. This regional center produces analysis and forecast information for the tropical latitudes supplementing the mid- and high-latitude products of the National Meteorological Center.

PRIMARY CENTERS

The Department of Commerce operates three primary centers--the National Meteorological Center at Camp Springs, Md., the National Hurricane Center at Miami, Fla., and the National Severe Storms Forecast Center at Kansas City, Mo.

The first of these, the National Meteorological Center (NMC), provides basic weather analyses and forecasts for the Northern Hemisphere and for portions of the Southern Hemisphere. During a typical day, NMC processes more than 40,000 surface observations, 2,000 ship reports, 1,500 upper air soundings, several hundred vertical soundings derived

from satellite data, 2,800 aircraft reports, and global cloud-cover data from weather satellites. NMC products include more than 400 charts for facsimile transmission and 200 messages for teletypewriter distribution daily to its users primarily in North America but including others in overseas areas as well. The processing complex at NMC includes two computers jointly shared with the satellite service. New and improved forecast models under development and increases in the amount of satellite data being processed support the need for an expansion of the main memory and of the disk storage capability.

The National Hurricane Center (NHC) is the second primary center and provides basic forecasts and warnings of hurricanes in the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico for all Federal agencies and user groups. NHC performs research directed toward improving the timeliness and accuracy of hurricane warnings and is assisted in this effort by the National Oceanic and Atmospheric Administration's National Hurricane Research Laboratory also at Miami and by the National Meteorological Center.

The third primary center, the National Severe Storms Forecast Center (NSSFC), is the source for severe thunderstorm and tornado watches in the United States in support of civil needs. This center is responsible for the preparation and distribution of watches that designate areas where the likelihood of severe thunderstorms or tornadoes is high. Watches based on an intensive and continuous review of the Nation's weather are issued as required while severe weather outlooks are issued three times per day.

Major needs of the NSSFC are to reduce the size of the watch area (now averaging about 27,000 square miles), increase the lead time of watches, and to be more specific as to time and place of occurrence. Although methods used in forecasting and warning of tornadoes and severe thunderstorms have significantly improved over the past 20 years, unmet needs for better detection capability and for improved forecast techniques remain. In addition, all centers will require early installation of Automation of Field Operations and Services (AFOS) equipment to allow for effective implementation and operation of the wide-reaching streamlining of the entire field structure.

The Department of Defense operates two primary centers--the Air Force Global Weather Central at Offutt AFB, Nebr., and the Navy Fleet Numerical Weather Central at Monterey, Calif. The Air Force Global Weather Central (AFGWC) provides basic analysis and forecast products in support of world-wide Defense aerospace and ground operations. Products from AFGWC are distributed to globally dispersed Department of Defense facilities and forces by facsimile, teletypewriter, and other high-speed communications systems. AFGWC provides severe weather warnings to approximately 600 Department of Defense and Defense-contracted installations and facilities. Areas are depicted within the conterminous United States having the potential to produce weather phenomena which can be hazardous to aircraft and ground operations. In addition, point warnings are provided for a large number of military locations. AFGWC needs to upgrade its computer system to handle increased data processing loads and must assure continuous operations to satisfy world-wide military requirements.

The second Department of Defense primary center, the Navy Fleet Numerical Weather Central (FNWC) provides analysis and forecast products in support of naval requirements. Products from FNWC are disseminated over the Naval Environmental Data Network to fleet weather centrals, facilities and Naval Weather Service environmental detachments located throughout the world, and to naval ships through interlinking fleet facsimile and teletypewriter broadcasts. Exchanges of products among Department of Defense processing centers are made by means of computer-to-computer high-speed data links. To handle the needs of fleet and shore stations more effectively, equipment for processing satellite information and for handling and displaying other meteorological and oceanographic data is required.

The threat of power shortages, computer outages or other incidents affecting National Oceanic and Atmospheric Administration facilities can jeopardize the capability of NMC to provide basic weather analyses and forecasts. A cooperative arrangement, outlined in the *Federal Plan for Backup Among Operational Processing Centers*, exists to provide continuous service in such a contingency. In an attempt to broaden the backup support and to update transmission schedules, the plan is undergoing revision. Should NMC operations fail because of a power or computer failure, AFGWC will provide selected meteorological charts for entry on the National Facsimile Network at Kansas City. Arrangements have also been made for AFGWC to provide NMC's aviation winds forecasts and NSSFC's

severe local storms forecasts if those centers are out of operation for an extended period. These arrangements are detailed in the *Federal Plans for Cooperative Backup for Severe Local Storms and Aviation Winds Forecasts*. In addition, an agreement has been reached between the Departments of Commerce and Defense for FNWC to provide backup guidance material from its computer output to support the NMC forecast operation.

AREA AND GUIDANCE CENTERS

Area and guidance centers form the intermediate level in the weather analysis and forecasting structure. These centers, using the products of primary centers, are responsible for forecasts and warnings within their assigned areas. They also provide detailed guidance and support to civil or military weather service offices within their areas.

The Department of Commerce operates 52 Weather Service Forecast Offices (WSFO). Each WSFO provides forecasts and warnings for one or more states or for portions of larger states. Forecasts are issued twice daily for periods up to 48 hours. Area or statewide warnings are issued to the public in critical weather situations. These forecast offices also provide the main field forecast support for all specialized forecast services such as marine, aviation, agriculture, and forestry weather.

Several WSFOs have additional forecast functions. After coordination with NHC, the WSFOs at Boston, Mass., Washington, D.C., New Orleans, La., and San Juan, P.R., are responsible for hurricane warnings in their respective areas of responsibility. In accord with international agreements, the Eastern Pacific Hurricane Center at WSFO San Francisco, and the Central Pacific Hurricane Center at WSFO Honolulu, provide forecast and warning services for the eastern and central Pacific Ocean similar to those NHC services for the Atlantic, Caribbean Sea, and Gulf of Mexico. Hurricane advisories and bulletins prepared by the Warning Offices for the general public and marine interests contain the position, intensity, direction and rate of movement, and other significant characteristics of the storm. Aside from forecasting functions, all WSFOs assist in disaster preparedness by cooperating with Federal, State, and local agencies in areas where destructive storms are likely. Eighteen of the WSFOs serving 21 states have specialists assigned for this activity.

To assist both the primary centers and the WSFOs in the application of satellite data to the preparation of short-term forecast and warning products, Satellite Field Service Stations (SFSS) have been established and collocated with NMC, NHC, NSSFC, and with the WSFOs at San Francisco and Honolulu. High-resolution weather pictures from the geostationary operational environmental satellites are distributed over specially conditioned lines to SFSS and WSFO photorecorders on a twice-per-hour (or more frequent, if needed) basis. Satellite meteorologists at each SFSS analyze the pictures and assist WSFO staffs in interpreting and using the data.

All WSFOs are planned to be equipped with AFOS equipment over the next four to five years. The objective is to introduce modern methods of data handling, display, and distribution to provide for an improved and much more responsive field forecast and warning system. The concept will include minicomputers and mass storage capability at each location connected by a national high-speed communications link.

The Department of Defense operates two area and guidance centers in the United States and seven in overseas areas to meet its global military requirements. These centers are located respectively at Norfolk, Va., Colorado Springs, Colo., and in Japan, Guam, Hawaii, Spain, Iceland, and two in Germany. These area and guidance centers receive products from the two primary Department of Defense centers in the United States and, in turn, prepare forecasts, warnings, and planning guidance oriented to the area of responsibility and type of operations (air, sea, or ground) being conducted by the supported military command.

SPECIALIZED CENTERS

Specialized centers meet the unique requirements of a specific user group. With funding support from the National Aeronautics and Space Administration, the Department of Commerce provides small but highly specialized service to support the space program. The National Oceanic and Atmospheric Administration (NOAA) National Climatic Center at Asheville, N.C., jointly operated and funded with the Department of Defense is the central archival, processing, and service center for weather records collected by all Federal agencies.

The Department of Defense operates two specialized centers--the USAF Environmental Technical Applications Center (USAFETAC), Scott AFB, Ill., with subunits at Washington, D.C., and

Asheville, N.C.; and the Joint Typhoon Warning Center, Guam. USAFETAC conducts climatological studies for operational planning, quality control of data taken by Department of Defense units, and archiving of specialized military observations. The Joint Typhoon Warning Center on Guam prepares typhoon warnings for the North Pacific west of longitude 180° and for the Bay of Bengal.

NOAA activated two new specialized units in FY 1975--the Center for Climatic and Environmental Assessment (CCEA), and a National Oceanographic and Atmospheric Satellite Data Center. CCEA relates the impact of climate and climate variation to national and international socioeconomic problems such as food production, demand/distribution of energy, and availability of living marine resources. The Center's Headquarters and Computer Modeling Division is located at the University of Missouri, Columbia, Mo.; while its Assessment Division is located in Washington, D.C. To consolidate satellite data services, NOAA established a National Oceanic and Atmospheric Satellite Data Branch. This Branch is collocated with the National Environmental Satellite Service, but is a subelement of the National Climatic Center. The branch provides a dedicated satellite data bank and is a centralized source of satellite photos for the user community.

Program Changes for Fiscal Year 1976

Table 19 lists the total operational costs, by agency, for the three types of centers for FY 1975 and FY 1976. This table has been changed to include Department of Commerce's funds for public weather forecast preparation within the Area and Guidance Centers instead of under Weather Service Offices in Table 21 of the Dissemination section. Planned increases for FY 1976 include $5,264,000 by Defense and $1,066,000 by Commerce. These increases for the analysis and forecast function involve mainly computer improvements and added operational costs.

Increases for the Air Force Global Weather Central include upgrading of an 1108 computer to an 1110 at a cost of $1,500,000; enlarging of the system to provide uninterrupted power for computer operations at a cost of $1,008,000; and added computer operators and computer lease costs at $1,652,000. The major increase planned for the Fleet Numerical Weather Central is $3,500,000 for purchases of equipment to process meteorological satellite information. Offsetting these increases for Department of Defense are two decreases, $2,155,000 for completed computer and construction costs at Air Force Global Weather Central, and $306,000 resulting from reduced funding for weather modification.

Department of Defense changes for FY 1975 included an increased cost of $645,000 for the planned move of the USAF Environmental Technical Applications Center to Scott AFB, and for computer operator personnel, and rentals.

In FY 1976, Department of Commerce plans an increase of $928,000 to double the main memory capacity and increase the disk storage of the large computer system shared by the National Meteorological Center and the National Environmental Satellite Service. An increase of $198,000 would be used to continue processing marine meteorology and air-sea interface data in support of world-wide oceanographic operations, offset in part by a reduction of $60,000 in the cost of publishing high altitude (rocketsonde) data.

FY 1975 program changes by the Department of Commerce include elimination of the four Regional Warning Coordination Centers located at New York City, Ft. Worth, Kansas City, and Salt Lake City as a

Table 19.--Agency operational costs by type of center
(Thousands of dollars)

Agency	Primary		Area and guidance		Specialized		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
Commerce	32,323	33,251	11,017	11,017	26,523	26,661	69,863	70,929
Defense	15,953	21,469	7,334	7,164	5,949	5,867	29,236	34,500
NASA	.....	.....	.....	.....	542	498	542	498
Total	48,276	54,720	18,351	18,181	33,014	33,026	99,641	105,927

result of personnel reductions. The winter warning coordination function will now be handled by nine WSFOs while other severe storm coordination will be accomplished by the National Hurricane and National Severe Storm Forecast Centers in conjunction with the appropriate WSFOs.

The Department of Commerce plans to establish a new four-man forecast technique development unit at the NSSFC using funds of $273,000 deferred in FY 1975. The primary goal of the unit would be to develop improved severe thrunderstorm and tornado techniques making use of all available meteorological information including the new geostationary operational environmental satellite data that has recently become available. In addition, $300,000 has been added as a result of an FY 1975 program change to provide computer programming support at the National Meteorological Center for AFOS. Base funding will be used to procure AFOS equipment for NMC, NSSFC, NHC, and NCC.

COMMUNICATIONS

Description

Communications are vital to the functioning of all meteorological services. Because the weather is changing constantly, communications facilities must be able to relay meteorological data and information rapidly for timely centralized processing and for direct application by many user groups such as civil and military weather offices, and other government and local agencies. To promote coordinated communications planning, the Office of Telecommunications Policy set forth a policy in its Circular No. 12, dated October 12, 1973, which designates lead agencies for respective types of communications. In this policy statement, the Department of Commerce was named as the lead agency for environmental communications. In August 1974, an initial *National Environmental Communications Summary Plan* was published as the first step toward improving interagency coordination and planning for future environmental telecommunications. This plan includes an inventory and analysis of existing and planned telecommunications systems of the Departments of Commerce, Defense and Transportation.

The major meteorological communications systems in use are given in the following subsections.

TELETYPEWRITER AND HIGH-SPEED SYSTEMS

The teletypewriter and high-speed communications systems provide the needed collection and distribution of alphanumeric weather data and information with agency roles as follows:

- The Federal Aviation Administration provides the basic national teletypewriter system used to collect and distribute weather observations and forecasts common to the other agencies
- The Department of Commerce provides internal communication systems and is responsible for certain international circuits required to support the World Meteorological Center at Camp Springs, Md.
- The Department of Defense supports and maintains those systems unique to military requirements.

Federal Aviation Administration

The Modernized Weather Teletypewriter Communications System consolidates the circuit control and relay functions of Services A, C, and O into a single Weather Message Switching Center (WMSC) at Kansas City. These functions are performed automatically by computers combined to operate as a real-time store and forward communications switch. All Service A and C circuits extend directly into the WMSC. Certain Service O circuits also extend directly into the computer switch, while others, from overseas points, pass through the Aeronautical Fixed Telecommunications Network switch which is collocated and interconnected with WMSC. Computer-to-computer links provide for the exchange of data between WMSC and the National Meteorological Center (NMC) at Suitland and between WMSC and the Air Force Automated Weather Network switching facility at Carswell AFB, Tex.

Circuits of the Modernized Weather Teletypewriter Communications System are described as follows:

- *Service A Area Circuits*: Forty-four 100-wpm (words per minute) multipoint half-duplex circuits designed solely to meet the collection and routine distribution requirements of the Federal Aviation Administration (FAA) and National Weather Service (NWS) user. Other users may obtain receive-only drops on these circuits if their needs are compatible with those of FAA and NWS.

- *Service A Request/Reply Circuits*: Forty-four 100-wpm half-duplex circuits which parallel the Service A Area Circuits and enable Government flight briefing facilities to obtain information not routinely transmitted to the associated area circuit.
- *Service A Low-Speed Nongovernmental Circuits*: Sixteen 100-wpm multipoint circuits for distributing data to meet the requirements of nongovernment users, principally airlines whose needs are not satisfied by the area circuits.
- *Service C Area Circuits*: Six 100-wpm multipoint half-duplex circuits for collecting and distributing basic meteorological data to serve both government and nongovernment users.
- *Service O Area Circuits*: 67- and 100-wpm multipoint half-duplex circuits for collecting and distributing international meteorological data to both government and nongovernment users.
- *Department of Defense Circuits*: Fifteen 100-wpm multipoint circuits and two 100-wpm point-to-point circuits for distributing selected civil environmental data to military customers in the continental United States.
- *Weather Service Forecast Office Point-to-Point Circuits*: Fifty-three 100-wpm full-duplex circuits to the Weather Service Forecast Offices (WSFOs) for transmission of forecast products to WMSC and receipt by WSFOs of supplementary weather data.
- *Weather Service Office Multipoint Circuits*: Eighteen 100-wpm multipoint half-duplex polled circuits designed to meet the collection and routine distribution requirements of the NWS. Other users may obtain receive-only drops on those circuits if their needs are compatible with the NWS.
- *Radio Broadcast Circuits*: 60- and 100-wpm distribution-only circuits for transmitting data on the World Meteorological Organization and Caribbean meteorological broadcasts.
- *Nongovernment Medium-Speed Circuits*: 1,200-bps (bits per second) multipoint receive-only circuits for distributing Service A, C, and O data to very-high-volume airline and other nongovernment users whose needs cannot be satisfied by low-speed circuits.
- *High- and Medium-Speed Links*:

  2,400-bps full-duplex computer-to-computer circuit for exchanging Service A, C, and O data between WMSC and NMC.

  1,200-bps full-computer-to-computer circuit for exchanging Service A, C, and O data between WMSC and the Air Force Air Weather Service.

  1,200-bps full-duplex Notice to Airmen circuit between WMSC and the National Flight Data Center.

  1,200-bps full-duplex point-to-point circuit for distributing Service A, C, and O data to Central Flow Control Facility.

  2,400-bps full-duplex computer-to-computer circuit for exchanging Service A, C, and O data between the Aeronautical Fixed Telecommunications Network and WMSC.

  2,400-bps full-duplex computer-to-computer dircuit for distributing Service A, C, and O data to the NWS's National Severe Storms Forecast Center.

  2,400-bps full-duplex computer-to-computer circuit for exchanging Service A, C, and O data between the Air Force Automated Network Switch and WMSC.

Department of Commerce

Radar Report and Warning Coordination (RAWARC) Teletypewriter Network--This network is used to collect and distribute radar reports and storm warning information. RAWARC is composed of five circuits terminating at the Radar Analysis and Development Unit in Kansas City as well as at the automated relay center in Suitland, Md. Traffic on RAWARC is basically unscheduled and is handled according to a priority system. The only regularly scheduled operation on RAWARC is an hourly collection of radar reports which is relayed to other circuits as required.

Special Communications Links Between Guidance Centers--A high-speed alphanumeric and

graphic computer link has been established between the National Meteorological Center/National Environmental Satellite Service and the National Hurricane Center to allow exchange of aircraft reconnaissance data, satellite data, and other processed information. A similar link has been established between the National Meteorological Center/National Environmental Satellite Service and the National Severe Storms Forecast Center.

International Circuits--In addition to the Service O circuits funded by the FAA, Department of Commerce has nine international circuits to exchange meteorological data among the United States and Canada, Russia, Cuba, Great Britain, Japan, Mexico, Brazil, the Central American nations, and Argentina. These include a Washington-Toronto high-speed circuit, a Washington-Moscow circuit for exchange of satellite information, a Washington-Central American loop, a Washington-Mexico low-speed circuit, a Washington-Buenos Aires low-speed circuit, and three other circuits--Washington-Bracknell (England), Washington-Tokyo, and Washington-Brasilia--that are part of the World Weather Watch main trunk circuit. The Washington-Bracknell circuit is also used to exchange facsimile charts.

Radio Circuits--Weather messages and observations prepared aboard ships at sea are transmitted by radio, primarily by Morse code, to shore-based radio stations and are relayed to NMC. The Teletypewriter Exchange Service, international communications carrier facilities, and Coast Guard circuits are used for the relays. More than 1,000 observations are automatically processed, separated geographically and consolidated into bulletins each day for distribution on domestic and international meteorological communications facilities.

Department of Defense

Automated Weather Network--This network, operated and maintained by the Air Force, is the backbone of the military weather communications system. It consists of four real-time communications switching computers at Carswell AFB, Tex., RAF Croughton, England, Fuchu Air Station, Japan, and Clark Air Base, Philippine Islands, linked by high-speed data circuits. The overseas Automatic Digital Weather Switches collect data from radio intercept sites and low-speed feeder circuits. These data are transmitted at 3,000 wpm to the continental United States switch at Carswell AFB where the information is examined, sorted, edited, compiled into specific weather messages, and switched to military and civil customers. Besides low-speed distribution to Department of Defense weather units, data are transmitted by high-speed circuits to the Air Force Global Weather Central, Fleet Numerical Weather Central, NMC, and the WMSC at Kansas City. All circuits are full duplex, permitting a total exchange of data that include reports from field units to military and civil processing centers and products from these centers to the field units.

Continental United States Meteorological (COMET) Teletypewriter System--The primary communications system for collecting, editing, and disseminating environmental data at military stations in the United States is COMET, which consists of three teletypewriter networks.

Each of these teletypewriter networks is subdivided into eight geographical areas. The COMET I network consists of half-duplex 100-wpm loop circuits used for collecting and disseminating airways data. The COMET II network consists of two half-duplex 100-wpm loop circuits. One circuit (COMET IIA) is used for collecting data, while the other (COMET IIB) is used for disseminating operational weather products and data. The COMET III network consists of half-duplex 300-wpm broadcast circuits used for disseminating synoptic and customer tailored data. Polling for data collection on COMET I and COMET IIA and for disseminating data over COMET IIB and COMET III are controlled by the 1108 computer at Carswell AFB.

Naval Environmental Data Network--This network provides for the dissemination of meteorological and oceanographic computer products from FNWC at Monterey to specially equipped locations in the United States and overseas. The network provides for rapid collecting, processing, disseminating, and displaying of environmental data and consists of on-line telecommunications equipment, automated display devices, digital computers, and associated circuitry.

FACSIMILE

Facsimile networks and broadcasts are designed to transmit graphical weather information from selected centers to civil and/or military weather offices and users. The Department of Commerce is responsible for the basic facsimile circuits, including those which fulfill international commitments. The Department of Defense has responsibility for those circuits filling unique military requirements.

Department of Commerce

The various internal and external networks listed below were established to serve different users and different geographical areas, and include both long-line and radio systems.

National Facsimile (NAFAX) Network--NAFAX is a long-line network used to distribute a comprehensive set of charts depicting analysis, forecast, and selected observational data to civil and military weather service offices and to a variety of other users. Basically a graphics network, NAFAX serves approximately 250 NWS offices, 400 military and civil governmental offices, and nearly 350 nongovernmental users--more than 1,000 drops in all.

With the exception of the radar summary charts prepared by the National Severe Storms Forecast Center and digitized cloud pictures prepared by the National Environmental Satellite Service (NESS), all materials originate at NMC. The Network extends throughout the United States, with extensions into Canada at Vancouver and Montreal. Charts are relayed to Alaska over military channels from West Sweetgrass, Mont. In Alaska, selected charts are put on the Intra-Alaska Facsimile Network circuit. Selected charts are also relayed to Honolulu over a link from NMC.

National Aviation Meteorological (NAMFAX) Network--NAMFAX is a long-line network designed to provide selected civil and military weather offices with graphic guidance materials including satellite products in support of international high-altitude aviation operations. The network operates at 120 and 240 scans per minute with automatic selection of speed and mode depending on the type of product being transmitted. The network extends to the U.S. borders, and carries products to Canada, Alaska, and Puerto Rico.

Forecast Office Facsimile (FOFAX) System -FOFAX is a long-line network designed to distribute NMC forecast guidance materials and NESS satellite products to the WSFOs. It is also used to distribute NESS-prepared digital mosaics obtained from satellite pictures and automatic picture transmission data acquired by NESS at Wallops Island and at the WSFO San Francisco. FOFAX operates at 120 or 240 scans per minute and has automatic selection of speed and mode.

Tropical Regional Analysis Facsimile Circuit (TROPRAN)--TROPRAN is a long-line network used to distribute tropical area analyses and prognoses. It carries NMC products for use by the National Hurricane Center and provides NESS tropical-area satellite data for all users on the circuit.

Intra-Alaska Facsimile Network--This network is a system of microwave, troposcatter, cable, and high-frequency radio facilities used to distribute graphic materials throughout Alaska. Besides the charts prepared by WSFO Anchorage, selected charts are switched automatically into the Network from NAFAX and NAMFAX. At present the Intra-Alaska Facsimile Network serves 10 National Oceanic and Atmospheric Administration (NOAA), one Coast Guard, and 13 Department of Defense offices. FAA and NOAA provide funds for that portion of the NAMFAX circuit from the international border-crossing point at Blaine, Wash., to Smugglers Cove, Alaska. NOAA provides approximately 90 percent of the funds for circuitry within Alaska, and Department of Defense funds the remainder.

Other Facsimile Broadcasts

International radio facsimile meteorological broadcasts are transmitted via leased commercial HF radio transmitter facilities. These broadcasts are beamed primarily toward the Caribbean, Central America, South America, and southwest Pacific areas.

Marine HF radio facsimile meteorological broadcasts are transmitted from the east and west coasts of the United States via Coast Guard transmitter facilities and are intended primarily for reception by ships at sea.

Real-time reconstructed radar images consisting of weather echoes with added handwritten annotations and geographical overlay are transmitted in facsimile mode from WSR-57 radar sites equipped with transmitters. There are 35 transmitter sites presently equipped with this capability. The two operational modes being employed are hard-wire private line circuits leased from common carriers and direct-distance dialing via the telephone companies. Either of these services are available to all interested government and nongovernment users.

Department of Defense

Strategic Facsimile Network--The Strategic Facsimile Network is a landline and microwave net that extends to selected Department of Defense users at about 70 locations in the United States. AFGWC at Offutt AFB serves as the transmitting facility. The Strategic Facsimile Network supplements the facsimile systems of the Department of Commerce by providing specialized graphical data oriented to

military operations. It is used primarily to support the readiness of U.S. strategic weapons forces and secondarily to support airlift and tactical forces. The Network operates at 120 or 240 scans per minute. Most products are computer generated and introduced into the system through digital-to-analog converters.

Overseas Facsimile Networks--In order to satisfy the needs of military customers overseas, AFGWC at Offutt AFB transmits specialized products to locations in Europe over the European Facsimile Network (EURFAX) and to the Pacific over the Pacific Facsimile Network (PACFAX). The PACFAX operates at 120 or 240 spm while EURFAX operates at 120 spm. EURFAX will be upgraded to a digital graphics system in the 3rd quarter of FY 1976 using new graphics recorders funded for in previous years. Most products are generated by AFGWC; however, a limited number of specialized, manually prepared products are injected into EURFAX by the European Tactical Forecast Unit at Kindsbach, Germany, and into PACFAX by the Asian Tactical Forecast Unit at Yokota Air Base, Japan.

Fleet Weather Broadcasts--The Naval Communications System supports the Naval Weather Service in its requirements for specialized operational communications. Meteorological traffic is handled in the same manner as other Navy traffic; no center or unit is dedicated exclusively to meteorological communications. Meteorological information is transmitted to operating forces of the Navy by means of radio (continuous wave, teletypewriter, and facsimile) broadcasts. Designated Fleet Weather Centrals are responsible for contents of these broadcasts which include observations, analyses, forecasts, and warnings. In preparing broadcasts, the centrals and facilities make use of, not only their own specialized products and those from FNWC, but also--to the extent possible--products from the Basic Meteorological Service and data from Department of Defense's Automated Weather Network.

Program Changes for Fiscal Year 1976

Table 20 lists the total costs by agency for the various communications types for FY 1975 and FY 1976. Of the agencies involved in the meteorological communications function, the Department of Defense is planning an increase of $1,696,000 while all other agencies plan either little change or small reductions in FY 1976.

The Department of Defense plans include an Air Force increase of $302,000 and $684,000 in teletypewriter and facsimile costs, respectively. Small decreases in circuit costs will be offset by sharp price increases for paper expendables.

Navy plans increases of $500,000 for high-speed communications in support of FNWC satellite data processing and $200,000 for added teletypewriter and facsimile communications costs.

FAA plans include a decrease of $328,000 due to reductions in the procurement and installation of teletypewriters for airport flight service stations while

Table 20.--Agency operational costs, by type of communications
(Thousands of dollars)

Agency	Teletypewriter and high-speed systems		Facsimile		CW, voice, telescriber and television		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
ERDA	10	11	10	11	.....	.....	20	22
Commerce	5,680	5,680	3,056	3,056	.....	.....	8,736	8,736
Defense	15,126	15,992	7,106	7,934	153	155	22,385	24,081
NASA	39	34	22	22	34	19	95	75
Transportation:								
Coast Guard	130	141	87	93	.....	.....	217	234
FAA	20,530	20,202	726	807	.....	.....	21,256	21,009
Total	41,515	42,060	11,007	11,923	187	174	52,709	54,157

an $81,000 increase for added facsimile costs produces a net decrease of $247,000.

Major changes to the FY 1975 communications programs include an Air Force increase of $351,000 to cover increased support costs and an FAA increase of $1,665,000 for improved teletypewriter services.

DISSEMINATION

Description

Dissemination is the final link in the forecast and warning process. For effective use, warnings must reach all affected members of the public and responsible officials with minimum delay and must convey maximum understanding. This is necessary to allow adequate lead time for making decisions and for taking protective actions to mitigate the effects of weather events. The time requirement varies from a few minutes in the case of a tornado warning to several days for widespread snowmelt-type flood warnings. In order to serve the large variety of users and effectively meet the wide range of time requirements for product and warning delivery, a mix of dissemination methods is used.

Radio, television, telephone, teletypewriter systems, and newspapers are all used to varying degrees for disseminating environmental forecasts and warnings. They are all designed to serve multi-mission roles. Each routinely provides general weather information, warnings, and forecasts to the public and special user groups.

Although the dissemination system performs well in routine situations, it often is inadequate during periods of severe weather. This was dramatically

Destructive Xenia, Ohio, tornado of April 3, 1974.

illustrated in the National Oceanic and Atmospheric Administration (NOAA) report on "The Widespread Tornado Outbreak of April 3-4, 1974," where the need for improvements in warning dissemination was brought out strongly. Other previous disaster reports and surveys have identified similar unmet needs in the dissemination system. Improvements are being made to meet these needs and more are planned. In addition, the Automation of Field Operations and Services program promises to significantly improve the dissemination of forecasts and warnings internally to the meteorological services and more importantly to the public and specialized users.

WEATHER SERVICE OFFICES

NOAA has approximately 200 Weather Service Offices (WSOs) that disseminate forecasts and warnings to the general public and to responsible State and local officials, placing heavy reliance upon radio and television broadcasting. These weather offices throughout the country also make basic dissemination of hurricane and tornado warnings, with key dissemination nerve centers at the National Hurricane Center and the National Severe Storms Forecast Center. Also, many of these offices have been supplemented with specially trained personnel who provide weather information for agricultural and forestry user groups. A few WSOs are operated solely to provide weather information for specialized users, as necessitated by technical or economic considerations.

The Department of Defense operates over 300 weather service offices on land and aboard ship that provide forecasting, briefing, climatological, and consultant services in support of military weapons systems, facilities, and installations. Department of Defense mobile units provide weather support for maneuvers, exercises, and special military and contingency operations.

FLIGHT SERVICE STATIONS

The Federal Aviation Administration (FAA) network of 326 Flight Service Stations (FSSs) provides weather information to aviation interests at civil airports. Many of these FSS facilities also provide weather-briefing services by telephone to pilots at smaller airports that have no other weather information source. Some airports have both an FAA-FSS and a NOAA-WSO; the FSS personnel handle routine briefings, and the WSO or a nearby Weather Service Forecast Office (WSFO) handles requests for more detailed meteorological information.

MESSAGE TRANSMITTING SYSTEMS

Voice communications methods have a major role in meteorological services. Weather information is disseminated to the general public through telephones, telephone answering recorders, NOAA Weather Radio, and other radio broadcasts. Use of recorders for distributing weather information to public, aviation, marine, and other specialized groups allows a growing number of users to be served at minimum expense. For aviation users, FAA broadcasts recorded weather observations and NOAA-provided forecasts and warnings.

NOAA operates a continuous weather broadcast service consisting of 77 NOAA Weather Radio stations. These broadcasts, transmitted on frequencies of 162.40 MHz, 162.475 MHz, and 162.55 MHz, provide continuous weather forecasts and warnings and other pertinent weather information directly from weather offices to the local community consisting of the general public, mariners, safety officials, news media, utility companies, schools, and anyone else having need for up-to-the-minute information. Through a tone-alert device, specially equipped radio receivers can be demuted by the NOAA transmitter, thus giving an immediate alert to anyone having this special receiver. This alert would be followed by the warning information. The widespread tornado outbreak of April 3-4, 1974, emphasized the need to expand the coverage of NOAA Weather Radio stations.

The U.S. Coast Guard provides long-range weather broadcasts in the maritime regions by voice, radiotelegraph and facsimile from five stations in the Atlantic and Gulf of Mexico and seven stations in the Pacific. Additionally, there are thirty-seven Coast Guard stations making weather broadcasts in the coastal regions. This system is a vital part of the maritime weather dissemination program. The FM radio sytems are also being used as emergency communications to link essential Department of Commerce facilities with news media and public agencies in areas where hurricanes and severe storms frequently disrupt normal communications. The Department of Defense operates 101 two-way radio

facilities in the United States for direct voice contact between weather personnel and airborne pilots.

The NOAA Weather Wire Service (NWWS) is a system of statewide teletypewriter circuits used to distribute consumer-oriented weather warnings, forecasts, and data from WSFOs to the news media for relay to the public and various specialized users. It provides on an optional basis visual and audio capability to alert all users to critical incoming messages. WSFOs and WSOs have direct entry on these circuits. The WSFOs furnish broadscale information, and the WSOs enter local information. The Service also includes three 100-wpm teletypewriter overlay-relay circuits which enable state relay centers to obtain and further distribute the required information from other States. There is a need to expand this service from the present 35 states to all conterminous states so that the mass media will have available timely warning information on potential disasters for immediate relay to the public. Completion of the NWWS would make this service potentially available to some 5,000 radio stations, 600 television stations, and 1,700 newspapers in 3,000 cities and towns. The mass media subscriber pays for the use of a local line and equipment while NOAA funds for the line from the WSFO to the telephone company serving a particular community.

Telescriber systems are used at many civil and military airfields to disseminate observations, forecasts, and warnings to air traffic controllers, aircraft operations offices, and other users. Closed-circuit television is used extensively by the Department of Defense to distribute weather information and to brief pilots and operational control personnel on the weather.

There are over 115 cable television systems that automatically receive their local forecast from NWWS and continuously display this information on a special channel. Forecasts and warnings are automatically changed upon receipt via NWWS.

The National Weather Service is experimenting with an audio-visual weather service program over a channel of the Great Falls, Mont., cable television system. All information originates at the Weather Service Forecast Ofice and is sent to the cable office via coaxial cable for distribution to the television customers.

The Department of Commerce, U.S. Coast Guard, State and local governments, and private interests cooperate in a Coastal Warning System to warn pleasure boatmen and other marine interests that lack radio receiving equipment of impending weather conditions on coastal and inland waters. More than 400 flag or light displays are operated along the seacoasts, the shores of the Great Lakes, and on the inland waterways.

SYSTEMS IMPROVEMENTS

If weather information is to be of substantial benefit to civilian and military users, it must not only be accurate but also timely. Significant efforts are underway within the Departments of Commerce and Defense to improve the dissemination of weather information.

The Department of Commerce is implementing a program for the Automation of Field Operations and Services (AFOS) designed to materially enhance the ability to respond to impending weather disasters and to significantly increase the productivity of weather service personnel in providing weather information and warnings to the public.

The Navy has an effort underway for a new system known as the Naval Environmental Display Station (NEDS) which should become operational during FY 1976. NEDS has been designed to overcome present system (e.g., facsimile, teletypewriter) limitations, to permit expansion of environmental support (both meteorological and oceanographic), and to conserve personnel and equipment resources. The primary functions of NEDS are transmission, receipt, storage, manipulation and display of graphic, alphanumeric and satellite data. NEDS includes multi-colored visual displays of environmental parameters of tactical significance to the operating forces. Of significant importance is the capability to encrypt, transmit (via landline or multi-channel broadcast), and decode for viewing a complicated graphical picture in less than 10 minutes using existing 100 wpm teletypewriter circuits.

As part of a continuing program, Department of Defense and National Aeronautics and Space Administration conduct both short- and long-range studies and make use of consultants to assist in the analysis and design of systems improvements for the dissemination functions.

The U.S. Coast Guard, and the Departments of Commerce and Defense are reviewing present dissemination systems for the maritime regions and developing a plan to improve the timeliness and availability of weather forecasts to the maritime users.

Program Changes for Fiscal Year 1976

Table 21 lists the total operational costs, by agency, for each of the dissemination categories. Department of Commerce funds for public weather forecast preparation previously included under Weather Service Offices in this table are now shown in Table 19 under Area and Guidance Centers.

Planned major increases for the dissemination function include $17,175,000 by Department of Commerce, $3,956,000 by the FAA, and $832,000 by the Department of Defense. Department of Commerce's increase includes $12,460,000 for AFOS. This increase would bring the AFOS funding level to $17,267,000 including $1,266,000 deferred from FY 1975. No further increases would be required to complete implementation by 1981. When fully operational, AFOS is expected to generate savings and avoided costs of $11,500,000 annually with estimated operating costs of $6,000,000 for a net savings of $5,500,000 per year.

In FY 1976, Department of Commerce plans call for $12,350,000 of the AFOS increase to be used for procurement of equipment for 23 WSFOs and 23 WSOs while five positions and $110,000 would be used to initiate operation of the Systems Monitoring and Coordination Center. In addition, equipment for four National Centers, four River Forecast Centers, and 18 WSOs is planned for procurement using previously appropriated funds. Installation of equipment for three WSFOs, one River Forecast Center, two WSOs and the Systems Monitoring and Coordination Center purchased in FY 1975 also will begin.

Of the remaining increases planned by Department of Commerce, $1,455,000 would be used to complete the NOAA Weather Wire Service in thirteen remaining states while $3,560,000 would be used to complete the NOAA Weather Radio nationwide by 1979. The latter item would include installing 46 transmitters now on hand; upating 77 existing stations to improve reliability and reduce maintenance costs; and establishing 208 new sites by leasing or buying facilities depending upon whichever is least costly to the government.

Department of Commerce is further planning to reduce NWS National and Regional Headquarters personnel supporting the Weather Service Offices by 30 positions and $600,000.

FAA's planned increase for FY 1976 includes $2,775,000 for added operational costs related to increased pilot briefings, weather broadcasts, and for expansion of the en route flight advisory service. Equipment planned for replacing and expanding transcribed weather broadcast facilities and for the en route service would cost $1,100,000. FAA changes in FY 1975 included a decrease of $2,619,000 for reductions in planned procurement of broadcast equipment and services which was offset by an increase of $1,173,000 due to increased operational costs for pilot briefings and other related costs.

Department of Defense increases planned for the Navy in FY 1976 include $800,000 for procurement

Table 21.--Agency operational costs by type of dissemination to users
(Thousands of dollars)

Agency	Weather Service Offices		Flight Service Stations		Message transmitting systems		System improvements		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
ERDA	138	154	.....	.....	.....	.....	.....	.....	138	154
Commerce	10,678	10,378	.....	.....	15,481	20,496	4,807	17,267	30,966	48,141
Defense	26,794	26,895	1,135	1,953	445	454	3,473	3,377	31,847	32,679
NASA	.....	.....	.....	.....	66	78	8	8	74	86
Transportation:										
Coast Guard	.....	.....	.....	.....	212	221	.....	.....	212	221
FAA	.....	.....	8,033	9,508	9,493	11,974	.....	.....	17,526	21,482
Total	37,610	37,427	9,168	11,461	25,697	33,223	8,288	20,652	80,763	102,763

of ten Naval Environmental Display Stations and $143,000 for added operating and expendable costs. An Air Force reduction of $115,000 for personnel providing technical meteorological services and studies is planned. A similar program change in FY 1975 decreased planned expenditures by $846,000.

GENERAL AGENCY SUPPORT

Description

General agency support covers four activities--internal support, training, maintenance, and management above the operating level--that agencies must sustain to operate effective meteorological service programs.

INTERNAL SUPPORT

General mission-related activities in support of meteorological operations within an agency are necessary for providing service to users. These activities include the following types of programs:

- Engineering support for planning, preparing technical specifications, surveying equipment sites for suitability, accepting and installing new equipment, and calibrating, maintaining, and repairing commissioned equipment systems
- Scientific studies, services, and consultations to determine the feasibility of new programs and to increase the effectiveness of current programs
- Quality control of products to assure the maintenance of standards for accuracy and productivity
- Office quarters and employee housing at remote-area locations.

TRAINING

Training in weather observations, communications, maintenance. and similar technician-level skills is accomplished at schools operated by Federal agencies; professional-level training is obtained by attending accredited colleges and universities. Training costs include instructor and student pay, equipment, travel, books, and tuition.

The major portion of the Federal training effort is by Department of Defense agencies to meet their military requirements. Technician-level training is conducted at Department of Defense schools. The Air Force and Army use civilian colleges and universities for training of their professional-level personnel. The Navy provides professional-level education leading to advanced degrees at the Naval Postgraduate School in Monterey and uses civilian colleges and universities primarily for special or doctoral degree work. Some personnel trained under these Department of Defense programs are employed by civilian meteorological agencies after leaving the military service.

National Oceanic and Atmospheric Administration operates its National Weather Service Technical Training Center at Kansas City for training meteorological technicians, and electronics and facilities maintenance technicians. The Center also conducts a course in basic meteorological observations for Alaskan natives and, for all regions, an Upward Mobility Scientific Technician training program. A refresher course at the professional level for meteorologists is given at National Weather Service Headquarters in Silver Spring, Md. Other professional-level training is available through colleges and universities or in programs operated by other Federal agencies.

The U.S. Coast Guard operates a Marine Science Technician Class-A School for basic training in this rating. About 40 percent of the curriculum is devoted to meteorology. The Federal Aviation Administration Academy at Oklahoma City trains that agency's personnel in the meteorology required for air traffic control, weather observations, en route flight advisory service, pilot weather briefing, flight operations, and in communications equipment maintenance. The Environmental Protection Agency conducts air pollution meteorology training programs for professionals in air pollution control at the Federal, State, and local levels.

Some economies in training are being realized through use of one agency's training program by another, avoiding duplication of facilities and staffs. Also, Department of Commerce achieves savings in training costs by providing home study courses using both commercial and in-house correspondence programs to supplement formal residence courses.

MAINTENANCE

Maintenance is performed at central overhaul facilities and at regional and local shops. Most work is done at the local level where emphasis is placed on

preventive maintenance and emergency actions to restore vital facilities to operation.

The Departments of Defense and Commerce operate central overhaul facilities for major repair and rebuilding of entire items or major components of equipment. Regional maintenance facilities are supported by Department of Defense to assist local maintenance shops with preventive and corrective maintenance.

MANAGEMENT ABOVE OPERATING LEVEL

Management, supervision, administration, and logistic support are considered basic to units at the operating level; however, a certain amount of executive management, administration, and logistic support must come from higher echelons. In general, management above the operating level of units is confined to civil agency headquarters, to civil regional offices, and to similar headquarters in the military agencies.

Program Changes for Fiscal Year 1976

Table 22 lists the total operational costs, by agency, for each of the support categories for FY 1975 and FY 1976. Increases planned for general agency support include $3,050,000 by Department of Defense and $968,000 by the Federal Aviation Administration. Other agencies plan little or no increase for this function.

Within the Department of Defense, an internal support decrease of about $250,000 is planned. This change is the net result of a Navy increase of $286,000 for added equipment rental, office supplies, and manpower costs and an Air Force increase of $314,000 for position realignments and a reduction of $850,000 due to completion of Air Force Global Weather Central construction in FY 1975.

Department of Defense training expenditures are planned to increase by $2,450,000 and include $1,915,000 for new Air Force observer and forecaster training and for related costs. Navy's part of this item includes increased training and manpower costs of $335,000. Increases for maintenance include $492,000 by the Air Force for expendables and $181,000 by the Navy for test equipment and supplies.

FY 1975 program changes by the Air Force included increases of $673,000 for internal support relating to activation of five squadron headquarters; $1,208,000 for added manpower and expendable costs for maintenance; and $1,664,000 for increased training program activities. Manpower reductions by the Air Force in the management above operating level category resulted in a decrease of $1,533,000.

Federal Aviation Administration's total increase of $968,000 for FY 1976 is made up of added operational costs of $125,000 for internal support, $192,000 for training, $287,000 for maintenance, and $364,000 for management above the operating level. Changes in the FY 1975 program from last year's Plan for general agency support show an overall decrease of $650,000.

Table 22.--Agency operational costs by type of general agency support
(Thousands of dollars)

Agency	Internal support		Training		Maintenance		Management above operating level		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
ERDA	550	615	196	220	20	22	78	87	844	944
Commerce	5,157	5,157	1,108	1,300	18,304	18,304	17,733	17,541	42,302	42,302
Defense	7,038	6,785	18,642	21,092	13,370	14,127	9,308	9,404	48,358	51,408
NASA	69	65	15	18	53	293	81	52	218	428
Transportation:										
Coast Guard	.....	.....	95	103	.....	.....	60	64	155	167
FAA	3,200	3,325	1,679	1,871	4,157	4,444	3,154	3,518	12,190	13,158
Total	16,014	15,947	21,735	24,604	35,904	37,190	30,414	30,666	104,067	108,407

Meteorological Satellites

INTRODUCTION

Satellite information complements other forms of data needed for the preparation of weather and marine analyses, forecasts, and warnings. This technology has reached a significant milestone with the launch of prototypes of the Geostationary Operational Environmental Satellite which add a new dimension of near-continuous imagery critical to improving the environmental warning services. The prototype satellites for this system, National Aeronautics and Space Administration's Synchronous Meteorological Satellites, were launched on May 17, 1974 (SMS 1), and on February 6, 1975 (SMS 2). This section describes the meteorological satellite systems now in operation, the application to meteorological services, and the operational and research plans for service improvements.

NATIONAL OPERATIONAL ENVIRONMENTAL SATELLITE SYSTEM

The Department of Commerce, through the National Environmental Satellite Service (NESS) of the National Oceanic and Atmospheric Administration (NOAA), is the agency responsible for a national operational environmental satellite system. The Department is charged with operating and improving the system to meet the common requirements of all Federal agencies.

The system is based on space technology developed by the National Aeronautics and Space Administration (NASA), which also procures and launches spacecraft according to Department of Commerce specifications and is reimbursed with Department of Commerce funds. The meteorological objectives of the operational system are:

- Viewing the atmosphere regularly and reliably on a global basis, day and night, with direct readout to local ground stations within radio range of the satellite
- Continuous viewing of weather features and collecting and relaying environmental data from remote platforms such as buoys, ships, automatic stations, aircraft, and balloons
- Sounding the atmosphere regularly and reliably on a global basis and providing quantitative inputs to numerical weather prediction
- Applying meteorological satellite data toward improving weather services.

The operational system consists of flight programs directed to the above objectives, Command and Data Acquisition (CDA) stations, a satellite operational control center through which satellites are controlled and data are acquired, facilities for the processing and analyzing of satellite products, and laboratories for satellite sensor experiments and developing applications of satellite data. Within the conterminous United States, some direct readout and processed products are distributed to users over facsimile networks from a central processing facility. Also within the United States, Satellite Field Services Stations (SFSSs) have been established to analyze, interpret and distribute processed geostationary satellite products to regional weather service activities.

Flight Programs

The Improved TIROS (Television Infrared Observation Satellite) Operational Satellite (ITOS) has replaced the original TIROS Operational Satellite (TOS). TOS and ITOS have provided daytime global viewing and direct readout to local ground stations without interruption since February 1966. A brief history of the polar-orbiting satellite program has been given in previous Federal Plans. The current ITOS system is shown in figure 10.

ITOS E was launched on July 16, 1973, but did not achieve orbit because of a hydraulic pump failure

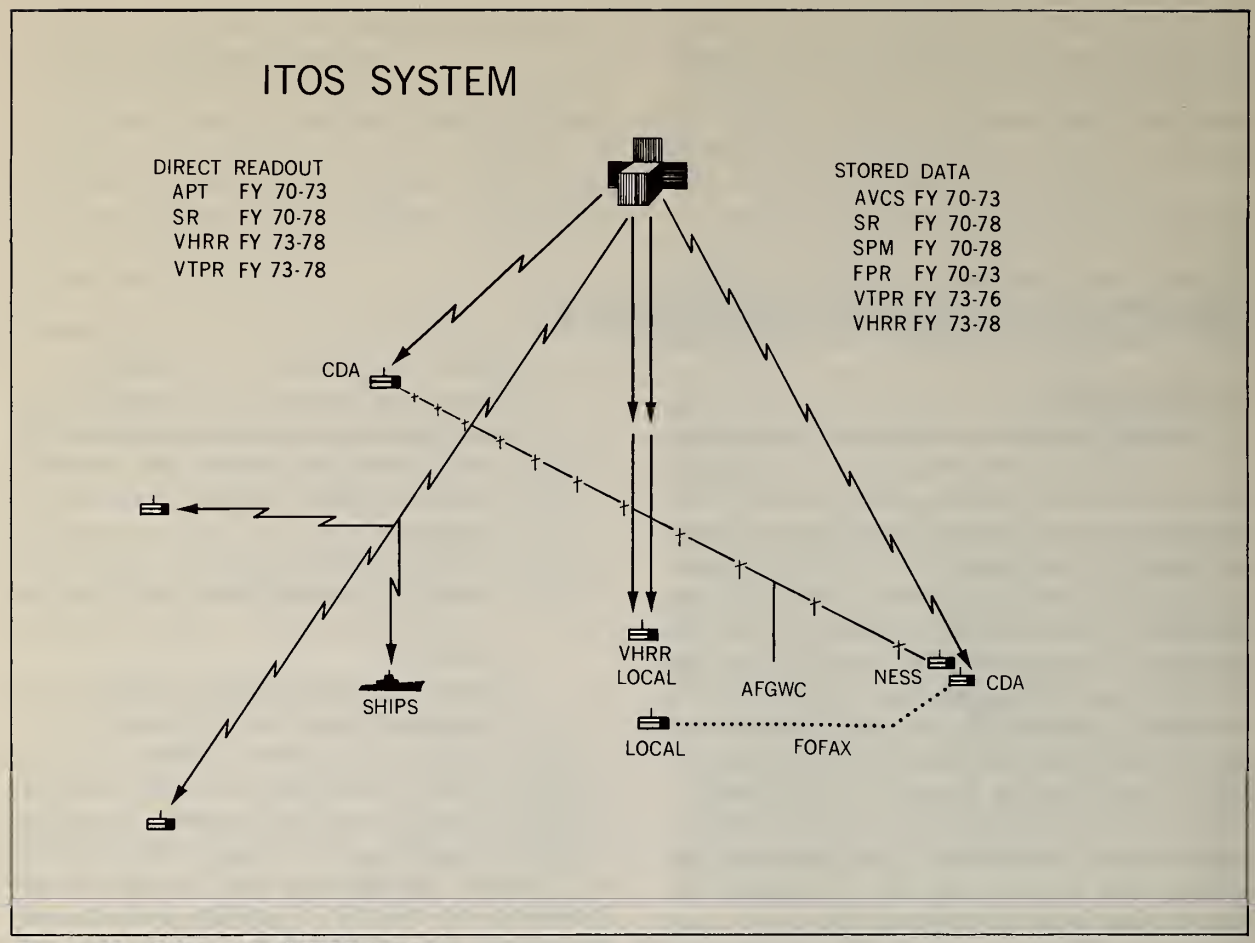


Figure 10.–Schematic of ITOS system.

in the second stage of the launch vehicle. ITOS F, renamed NOAA 3 after successfully achieving orbit, was launched on November 6, 1973, and became the NOAA operational satellite in early 1974. An added feature of NOAA 3, and all succeeding ITOS spacecraft, is the capability for direct readout of the Vertical Temperature Profile Radiometer (VTPR) radiance data.

NOAA 3 was used as the primary global data-gathering satellite during most of 1974. However, from mid-July through mid-October NOAA 2 was returned to primary duty to extend the life of the NOAA 3 VTPR instrument. NOAA 2 was placed in a standby status and all systems on NOAA 3 were brought into operation on October 16, 1974, to alleviate conflicts during the checkout of ITOS G (NOAA 4) which was launched on November 15, 1974. By the end of the year NOAA 4 had become the operational satellite, NOAA 3 was on standby, and NOAA 2 had been deactivated. NOAA 4 has an identical instrument complement to NOAA 3, except that the VTPR has been modified by the addition of baffles to prevent an out of field-of-view light leak which had caused some data contamination in the NOAA 2 and 3 instruments. An earlier model spacecraft, ITOS C, is being modified to the ITOS E configuration. ITOS C, now known as ITOS E2, will be available for launch during 1975.

A new dimension in satellite imagery was added during 1974 with the launch on May 17 of the Synchronous Meteorological Satellite (SMS) 1, NASA's prototype of NOAA's Geostationary Operational Environmental Satellite (GOES). This satellite is equipped with a Visible and Infrared Spin Scan Radiometer (VISSR) for earth viewing, a Space Environment Monitor (SEM) for monitoring the effects of solar activity on the Earth's environment, a Data Collection System (DCS) for collecting environmental data from a variety of remotely located observing platforms, and a Weather Facsimile

(WEFAX) broadcast system to provide centrally prepared products to a variety of remote users through the automatic picture transmission direct readout system of the polar-orbiting satellites.

SMS 1 was placed in orbit at 45° West longitude over the equator, from which point its primary mission from June 25 through September 23 was to support the Global Atmospheric Research Program Atlantic Tropical Experiment. From September 23 through November 16 SMS 1 was in transit to its permanent operating location near 75° West longitude. SMS 2 was launched on February 6, 1975, and placed at 115° West longitude.

The SMS VISSR provides the capability for near-continuous viewing of a circular area extending from 70° North to 70° South latitude. Full disc pictures are available at 30-minute intervals from the visible sensor which provides daytime viewing with a resolution of one kilometer and the infrared sensor which provides both day and night viewing with a resolution of eight kilometers. The SEM monitors solar X-ray flux, solar proton flux, and variations in the earth's magnetic field.

NOAA discontinued real-time acquisition and use of data from the NASA research Applications Technology Satellite (ATS) 3 in geostationary orbit over the northwest corner of Brazil on December 15, 1974. No video data have been obtained from ATS 1 in geostationary orbit over the eastern Pacific since October 15, 1972. However, both ATS 1 and 3 are used for WEFAX transmission of centrally prepared products to remote locations. The WEFAX service using ATS 1 and 3 will be continued into 1976 to allow recipients of the broadcast time to modify their ground equipment for reception by means of the SMS WEFAX.

Table 25 at the end of this section summarizes meteorological satellite flights through 1971. Table 26 lists flights launched or planned, indicating the functions provided, for the period 1972-75.

Data Applications

Global stored data are received at CDA stations, processed into products at the central processing facility, and distributed for use by the three primary analysis and forecasting centers–the NOAA National Meteorological Center (NMC), the Air Force Global Weather Central, and the Navy Fleet Numerical Weather Central. The processed products also are distributed to other NOAA, Department of Defense, and nongovernment agencies by means of facsimile landlines. The direct readout system provides regional observations in real time for detailed analysis and for use by other forecast centers and services throughout the world.

Techniques to derive quantitative information from satellite data, needed for world-wide numerical weather forecasting, continue to improve. For example, it now is possible to derive both daytime and nighttime upper-level wind vectors from infrared imagery obtained from the SMS satellites and to determine cloud-top temperatures more accurately. Infrared data, used in conjunction with the man-machine interactive processing system, make it possible to objectively derive cloud heights and thus assign wind vectors to the proper atmospheric layer. These wind data, along with satellite derived vertical temperature profiles, are integrated into numerical weather analysis and forecasting programs at NMC and are an important part of the data base for research studies on atmospheric circulation.

NOAA 4 high resolution infrared satellite imagery is used to depict and enhance oceanographic thermal boundaries and eddies particularly in the vicinity of the Gulf Stream. This information is used to minimize en route shipping time and to locate potentially good fishing areas. NOAA's high resolution satellite imagery also is used to prepare charts of sea and lake ice distribution. Significant ice boundaries, openings, and thin ice areas can be detected in the images thus improving estimates of the physical state of the ice. Economic savings and increased safety to shipping operations result from this effort.

NOAA 4 and NASA's earth resources technology satellite (LANDSAT) data are used to prepare snow cover maps in some of the Great Lakes' basins. These maps are used to determine the amount of snow that will melt and thus affect lake levels. In addition, these same data are used to measure surface water temperatures and to detect areas of upwelling. Upwelling can cause rapid changes in water temperatures and mixing conditions which may result in clogged municipal water intakes.

Quantitative estimates of snow cover, derived from satellite images, are prepared for 18 basins including the Genesee River, Red River of the North, the American River, and Willamette River. These estimates are sent to river forecast centers for use in river and flood potential forecasting. Satellite data are used in pollution monitoring. LANDSAT has provided data for identification and mapping of

major water masses and acid dumping sites within coastal zone areas such as the New York Bight. Evidence is also available to show that under certain conditions oil slicks in the ocean can be detected from satellite imagery.

OPERATIONAL PLAN

Spacecraft and Launching

The ITOS system will be maintained in operation with launches at about 12-month intervals. ITOS E2 will be launched in July 1975 or when required to maintain the continuity of the system.

Beginning with NOAA 2, these satellites include a capability for obtaining vertical temperature profiles and total moisture content of a column of the atmosphere. Addition of the Vertical Temperature Profile Radiometer (VTPR) completes the first operational system for sounding the atmosphere twice daily on a global basis, a major objective of the national operational environmental satellite program. NOAA 3 was the first ITOS satellite to provide a direct readout capability of the VTPR data, although limited to special receiving equipment.

The Very High Resolution Radiometer (VHRR) system provides high resolution imagery (about one kilometer at nadir). The VHRR operates mainly as a unique local readout subsystem to specially equipped locations, with limited high resolution storage capacity for data from selected remote areas. The vidicon camera systems in use on the earlier ITOS series have been discontinued; daytime viewing is performed by the combined day and night viewing and temperature sensing Scanning Radiometer (SR). The primary sensor complement--SR, VHRR, and VTPR--is expected to continue on the polar-orbiting satellites into FY 1978. The automatic picture transmission service will continue with the signal provided by the SR; day and night viewing is available from the SR which observes in both the visible and infrared regions of the spectrum. SR data may be received on the conventional ground-station recorder formerly used for automatic picture transmission signals, provided it is suitably modified. The details of the modification vary with the manufacturer and type of recorder. A solar proton monitor is carried as a secondary sensor.

A third generation polar-orbiting satellite series is being developed jointly by NASA and the Department of Commerce and will incorporate technology developed by the Department of Defense. The development activity is expected to lead to launch of a prototype, TIROS N, during 1978 followed by the first NOAA-funded satellite about five to six months later. A memorandum of understanding has been signed by the Department of Commerce, Department of Defense and NASA to assure commality on future operational polar-orbiting meteorological satellite systems. Coordination is carried out by an interagency Polar-Orbiting Operational Meteorological Satellite Coordination Board.

Improvements to be included in this series of satellites include more accurate temperature soundings in the troposphere and stratosphere with microwave channels to facilitate sounding retrieval in cloudy areas; advanced multi-channel imaging combining the capabilities of the ITOS Scanning Radiometer and VHRR; and the addition of a data collection and platform location capability. Direct broadcast of cloud cover imagery, both day and night, and atmospheric temperature sounding data will be continued.

The planned system will include two operational spacecraft in nearly orthogonal orbits, one crossing the equator southbound near 0800 local solar time, and one crossing northbound near 1500 local solar time. The spacecraft will be at 830 kilometers (the ITOS are at 1,450 kilometers) and will make about 14.25 orbits each day. There will be no instrument redundancy on the spacecraft as there is on the ITOS. Redundancy will be provided by virtue of having two spacecraft in orbit. Expected lifetimes of the operational spacecraft are two years in orbit.

Among the instrument systems that this spacecraft series will carry are a TIROS Operational Vertical Sounder, an Advanced Very High Resolution Radiometer, a Data Collection and Platform Locating System, and a Space Environment Monitor.

TIROS Operational Vertical Sounder is composed of three subsystems: the Basic Sounding Unit (BSU), the Stratospheric Sounding Unit (SSU), and the Microwave Sounding Unit (MSU). The BSU will have 14 channels and is modeled after the Nimbus Infrared Temperature Profile Radiometer. The SSU, to be provided by the United Kingdom, will have three channels and is modeled after the Nimbus Selective Chopper Radiometer experiment. The MSU will have four channels and is based on the Nimbus 5 Microwave Sounder.

Radiance measurements from the three sounders will be processed together to provide temperature soundings that are accurate to 1°C from the Earth's surface to 1 millibar, water vapor soundings to the tropopause, and total ozone content.

Advanced Very High Resolution Radiometer (AVHRR) is a scanner similar to the ITOS VHRR but providing images in four channels (later versions of the AVHRR will have a fifth channel, 11.5 to 12.5 micrometers, to provide additional improvement in sea surface temperature measurements). Direct broadcast of AVHRR will be available in four-kilometer and one-kilometer resolution. Onboard storage capacity will provide global coverage at four-kilometer resolution and selected coverage at one-kilometer resolution for central processing.

The Data Collection and Platform Location System is capable of acquiring data from up to 2,000 platforms per day. France will provide the satellite instrumentation for this system.

The Space Environment Monitor provides for world-wide monitoring of solar proton and electron flux density and the total energy disposition in the near-earth space environment.

The initial capability for near-continuous day and night cloud viewing and data collection and relay was established with the launch of SMS 1. Since SMS 1 was expected to have only a one-year lifetime, SMS 2 has been temporarily located at 115° West longitude. Should SMS 1 fail prior to the launch of GOES A, SMS 2 will be moved to 95° West longitude. After the launch and checkout of GOES A late in 1975, one satellite will be located near 75° West longitude and the second near 135° West longitude to provide near-continuous observations of the conterminous United States and the adjacent waters extending from east of Puerto Rico to west of Hawaii as depicted in figure 11.

Each satellite in the two-GOES system has the capability to transmit data to produce day and night images every 30 minutes; receive and transmit environmental information from up to 10,000

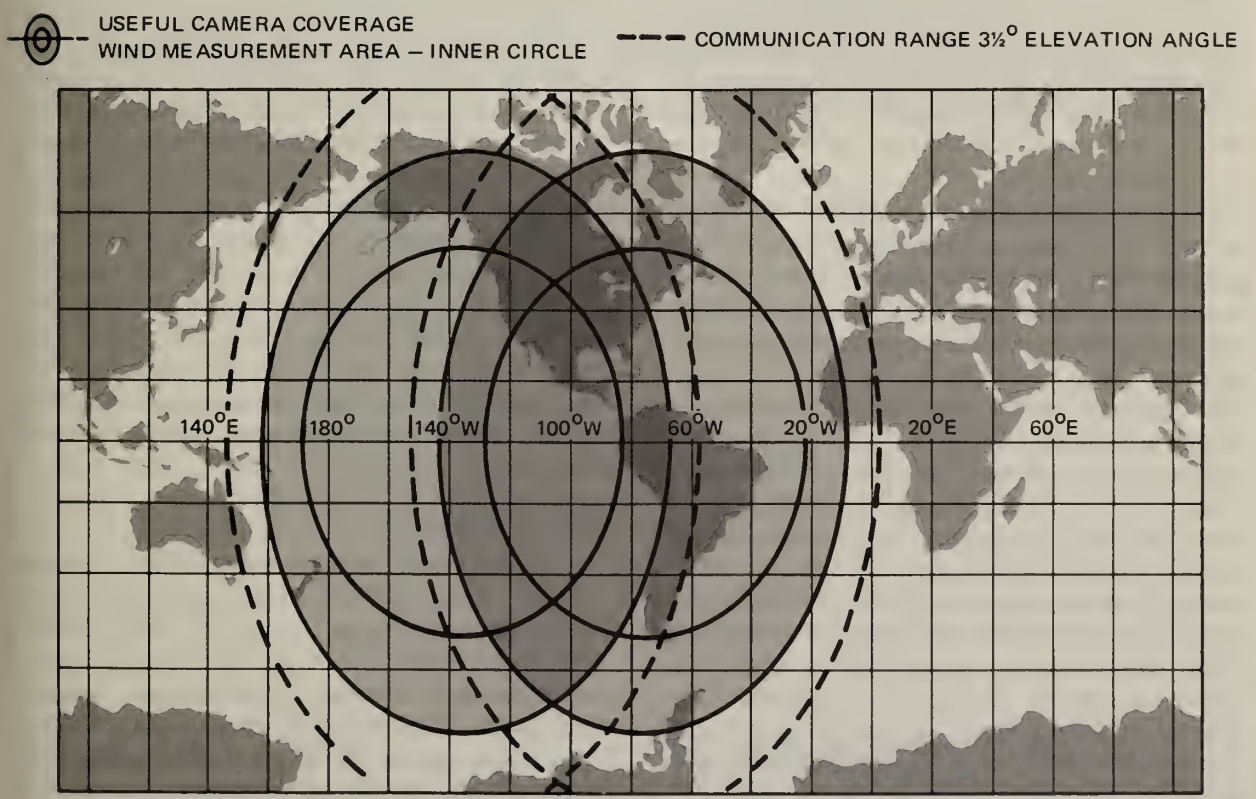


Figure 11.–Useful camera coverage (shaded area) and communications range (dashed lines) of a two-GOES system.

remotely located environmental observing platforms; transmit weather data and centrally prepared products to remote locations; and monitor the sun's activity for its effect on the Earth's environment.

The primary SMS/GOES instrment is a telescope/radiometer, called the Visible and Infrared Spin Scan Radiometer (VISSR), which provides both infrared and high resolution imagery. The VISSR is basically a telescope with a precision latitude stepping mechanism. The optical line-step scanner uses a combination of the satellite spin motion and a servo loop, using a torque motor drive together with a digital encoder, to permit scanning the full earth disc within view every 20 minutes, day and night. Allowing for retrace and nutation (the oscillation of the axis of any rotating body), dumping the entire sequence takes about 30 minutes. Partial disc pictures may be scheduled at more frequent intervals to meet special requirements. The VISSR operation is suspended during WEFAX broadcasts because the spacecraft power supply is inadequate to operate both simultaneously.

The infrared channel (10.5 - 12.6 micrometers) scans one line on each spin, providing about eight-kilometer resolution at nadir. The visible channel (0.55 - 0.75 micrometers) scans eight parallel lines providing one-kilometer resolution at nadir. The visible channel scan lines can be combined in groups of two or four to provide two- or four-kilometer resolution, respectively.

Meteorological charts and satellite images are transmitted by facsimile by means of the SMS/GOES satellites using 1691.0 MHz. Remote ground stations out to 76° geocentric arc from the subsatellite point can receive the broadcasts at an antenna elevation angle of 5° or greater.

The SMS/GOES satellites also collect and relay environmental data sensed by a variety of widely dispersed platforms such as river and rain gages, buoys, ships, and automatic weather stations. Each spacecraft can accommodate data from 10,000 or more individual observing platforms within a six-hour period. Data are transmitted from the platform to the satellite using frequencies in the 400 to 403 MHz band. Data received at the satellite are transponded at S-band frequency to the Wallops CDA Station for relay to NESS and further distribution to the users. The GOES Data Collection System (DCS) is shown in figure 12.

The GOES DCS is available to all environmental service agencies and organizations. However, use of the system is limited to collection of environmental data in accordance with applicable International Telecommunications Union regulations concerning use of allocated frequency bands. Users of the systems are responsible for the costs of the environmental sensors and platform, the radio equipment required to communicate with the satellite from the observing platform, and any unique equipment or communications needed to receive the data at the user's facility.

The SMS/GOES satellites also carry a Space Environment Monitor which measures energetic particles, magnetic fields, and solar X-rays. These data are relayed to NOAA's Space Environment Services Center for operational use in preparing forecasts and warnings of solar disturbances and their effects on the Earth's atmosphere. The Center is jointly operated with the Department of Defense.

Command and Data Acquisition

Command and data acquisition (CDA) functions include the ground facilities needed to command and control NOAA's operational spacecraft, acquire observed data from these spacecraft, and transmit these data to the central processing and analysis facility. These functions are carried out by the CDA stations at Wallops Station, Va., and Gilmore Creek, Alaska, and the Satellite Operations Control Center (SOCC) at Suitland, Md. The SOCC operates and controls the spacecraft in the operational ITOS and two-GOES systems through commands transmitted to the CDA stations for relay to the spacecraft. SOCC analyzes real-time engineering and telemetry data received from the spacecraft to determine performance and attitude. The CDA stations, the links between SOCC and the spacecraft, act independently should there be emergencies involving spacecraft malfunctions and ground communications outages.

Data Processing

Both NESS and Air Force Global Weather Central receive ITOS stored scanning radiometer data for computer processing to meet their requirements. The NESS central processing and analysis facilities are located at Suitland, Md. Principal products include about 1,400 vertical temperature soundings and approximately 5,000 sea surface temperature measurements each day, global cloud cover mosaics, plus charts of snow cover and sea and lake ice cover. Interpretative support is provided to users of these

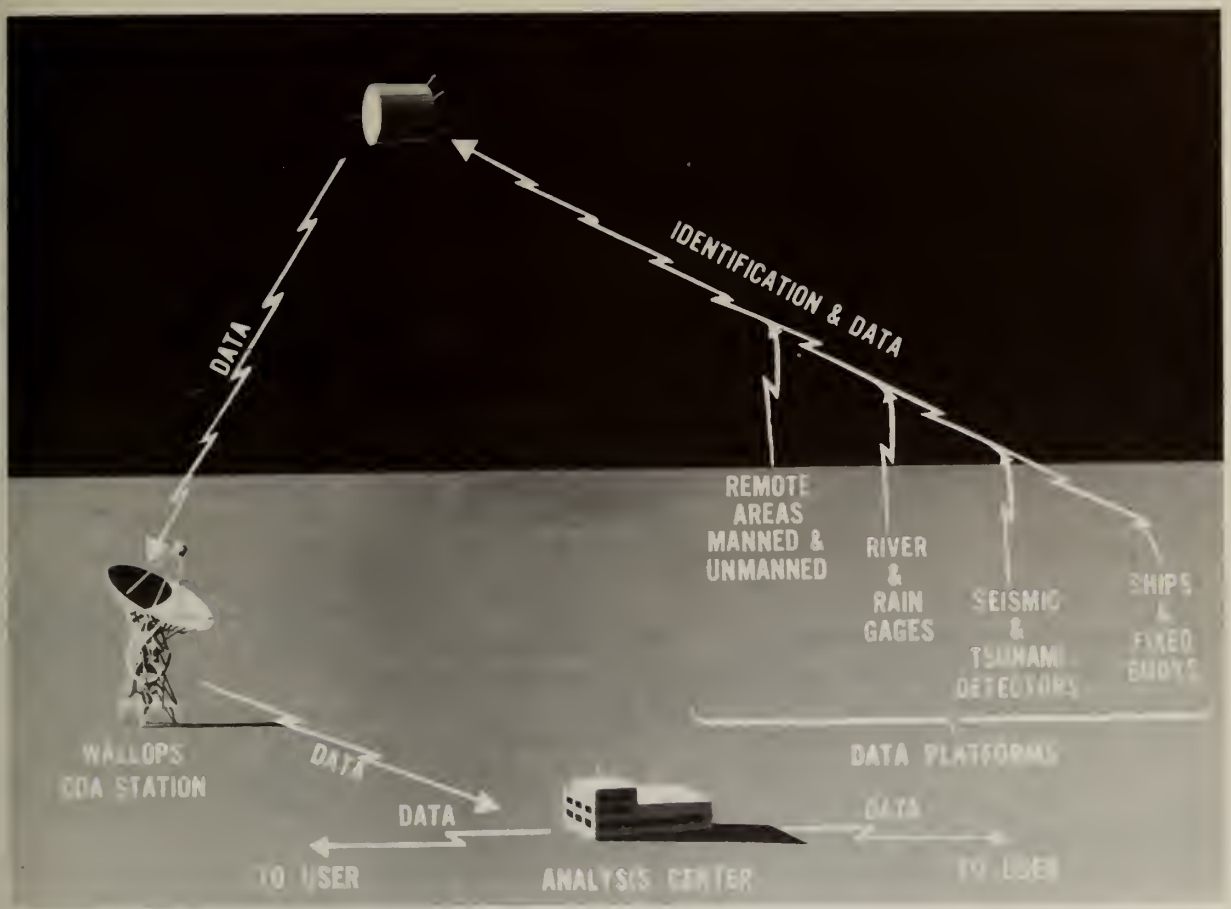


Figure 12.–Schematic of GOES Data Collection System.

data. The satellite data are permanently archived at the National Oceanic and Atmospheric Satellite Data Branch for use in developing new application techniques and for research purposes. The data are also exchanged internationally.

A study contract will be awarded late in FY 1975 to develop the ground data handling system that will support the third generation polar-orbiting satellite. Study results will be available so that the contract development option can be exercised during the latter half of FY 1976. The data handling system is expected to be checked out by mid-FY 1977.

Field Operations

An integral part of the SMS/GOES system concept is the Central Data Distribution System (CDDS) shown in figure 13. Stretched VISSR data are transmitted to the SFSSs through the Wallops CDA, the satellite and the CDDS. Infrared (IR) imagery is transmitted directly to the SFSSs via the CDA station. In addition, these data are supplied to the Winds Derivation Unit and several other units collocated with the CDDS.

A VISSR picture of the entire earth disk is available every 30 minutes. Since the accumulation of data is too voluminous to transmit on a real-time basis, these data are reduced to smaller geographical areas called sectors and transmitted to the applicable SFSS. The Weather Service Forecast Offices receive sectors of the VISSR data from the appropriate SFSS for display and local use. The IR data are transmitted directly from the CDA station to the SFSS and reduced to video imagery for analysis and interpretation. In the event of catastrophic failure of the CDDS sectorizing effort, IR data will continue to be available at the SFSS.

DEFENSE METEOROLOGICAL SATELLITE PROGRAM (DMSP)

The Defense Meteorological Satellite Program (DMSP) is an operational Department of Defense

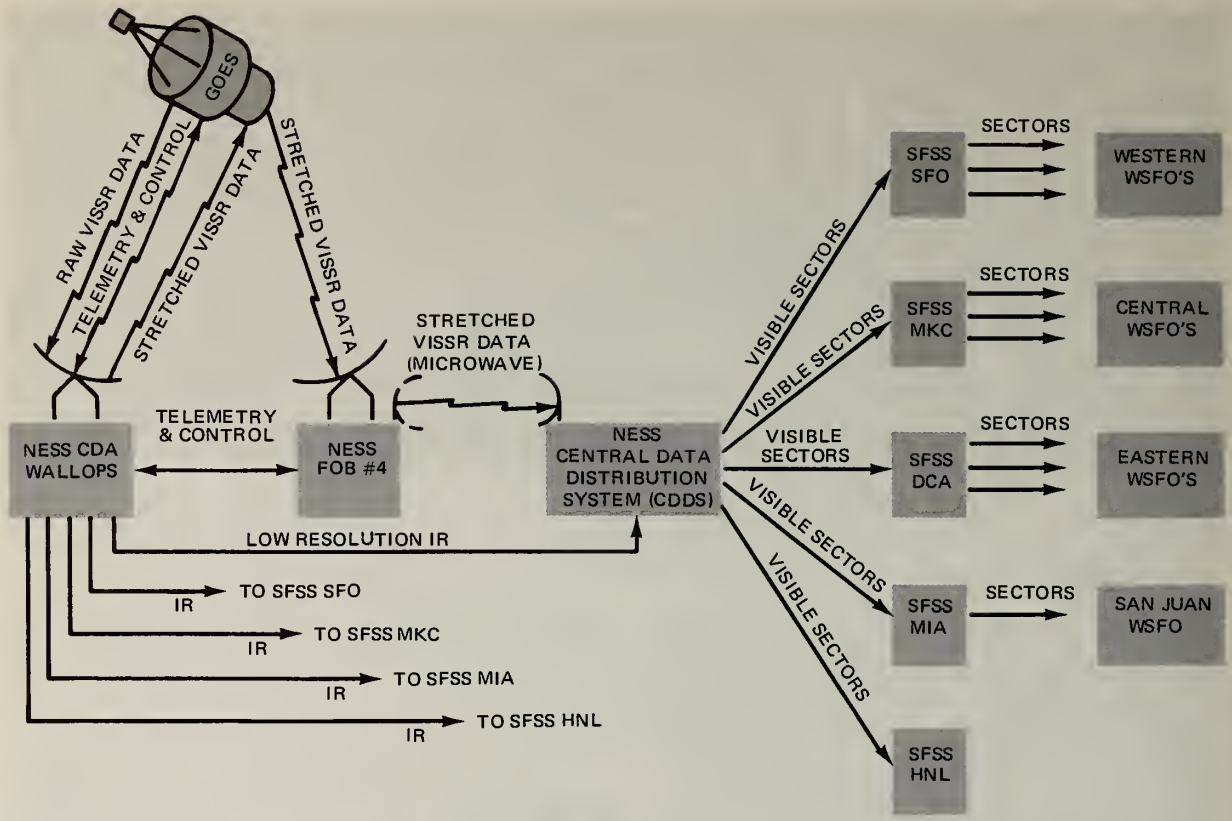


Figure 13.–GOES Centralized Data Distribution System (CDDS).

meteorological satellite system managed by Air Force. The Air Force furnishes DMSP data and all specifications for their use to NOAA/NESS as well as to Department of Defense meteorologists. NOAA/NESS is responsible for further dissemination of DMSP data to other U.S. government agencies and to the U.S. and international scientific communities.

Operational Characteristics

The DMSP was designed and developed under a total systems concept to provide unique meteorological data required by the Department of Defense. Sensors, communications, and ground processing facilities were developed with the primary objective of providing maximum responsiveness to the military decision maker. DMSP provides visual and IR representation of cloud images plus temperature profile soundings to the Air Force Global Weather Central, Offutt AFB, Nebr., for the entire globe at four observation times per day. DMSP provides direct real-time readout of regional visual and IR data to selected military locations around the world.

The DMSP routinely employs two polar-orbiting satellites. Each satellite is in an approximate 830 kilometer circular orbit with a period of 101 minutes. One satellite has an early morning local ascending equator crossing time and the other has a near-noon ascending equator crossing time.

Both satellites have visual and IR scanning radiometers. The visual sensors detect the brightness of reflected solar illumination from .4 to 1.1 micrometers. The IR sensors measure emitted radiation from 8 to 13 micrometers. The IR products are images of the earth and its atmosphere which are representative of their temperatures. Both IR and visual data may be obtained at a resolution of either one-third or two nautical miles. The spectral band width of the visual sensors was selected to optimize distinction among clouds, ground, and water. Electronic circuitry in the sensor converts the sensed IR energy directly into equivalent blackbody temperature, making temperature the directly

displayed parameter. The sensitivity of the two nautical mile visual channel covers seven orders of magnitude; this enables it to provide useful meteorological information from full daylight over highly reflected scenes to an illumination level roughly equivalent to half moon light.

Data Readout, Communications, and Data Processing

DMSP communications and ground processing systems are designed to produce usable products within five minutes after the data stream terminates. For direct readout, this means a data age of five to twenty minutes when ready for application to operational decisions. The central processing facility, AFGWC, is linked to the DMSP readout facilities by real-time, wideband communications. This allows for real-time recovery of (stored) recorded data such that the only timing increment added to the processing time is the transit time of the DMSP satellite from the observation scene to readout circle.

The data display unit has been designed with the following features to facilitate data interpretation:

- Orbital Normalization--Compensates for altitude and attitude differences
- Equal Area Projection--Foreshortening at the edges is removed
- Large Scale Transparency--The nominal scale is switch selectable at either 1:7.5 or 1:15 million
- Enhancement Options (Visual Data)--Variations in solar illumination are compensated for. The visual imagery displayed can be enhanced in the low, high, or a low-high mode.

Low enhancement gives better detail and definition to low albedo subjects like terrain, whereas high enhancement gives better detail to high albedo subjects like bright clouds. The combination of low-high enhancement gives improved detail to both low and high albedo features.

- Thresholding and Scale Expansion (IR Data). Thresholding segments the data into four levels (e.g., when thresholding at 270°K, 260°K, and 230°K, temperatures colder than 230°K are depicted as white, temperatures between 260°K and 230°K are depicted as light gray, temperatures between 270°K and 260°K are depicted as dark gray, and temperatures warmer than 270°K are depicted as black). The Scale Expansion allows the setting of a base temperature (e.g., 310°K) and displaying 16 shades of gray over 100°K (1:1 expand 310°K to 210°K), 50°K (2:1 expand, 310°K to 260°K), and 25°K (4:1 expand, 310°K to 285°K).

The entire ground system for direct, local readout is contained in a self-enclosed unit, including antenna, which is air transportable, making overseas deployment to full-scale operation a matter of hours. Additionally, the Navy has developed a similar local readout system for shipboard use. The centralized processing facility at the AFGWC has the capability to:

- Display high quality imagery for manual use
- Input the raw DMSP data stream directly into computers where it is converted into cloud parameters and collated with conventional meteorological data to produce a comprehensive numerical cloud analysis.

Table 23 lists the agency operational meteorological satellite program costs, by function, for FY 1975 and FY 1976.

SUPPORTING RESEARCH

Meteorological research conducted by NASA and the Departments of Commerce and Defense provides the data utilization techniques necessary to meet these agencies' major long-term objectives for a coordinated meteorological satellite program.

Global viewing, the first major objective, was largely achieved with the TIROS M and ITOS spacecraft. Efforts continue toward improved resolution, location, and display. Attention is also being given to developing methods for measuring additional environmental properties, to solving data and product distribution problems, and to improving ground stations.

The second major objective includes both continuous viewing and collecting and relaying meteorological data from instrumented platforms such as buoys, ships, automatic stations, aircraft, and balloons. NASA conducts experiments in support of this objective with its Nimbus and ATS series and is funding the SMS prototypes for the GOES operational spacecraft.

Table 23.--Agency operational meteorological satellite program costs, by function
(Thousands of dollars)

Agency	Spacecraft and launching		Command and data acquisition		Data Processing		Technical management and support		Total	
	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
Commerce	34,655	40,085	7,972	7,972	15,110	15,110	5,157	5,157	62,894	68,324
Defense:										
Navy	.....	.....	4,998	7,085	219	3,722	200	200	5,417	11,007
Air Force	19,600	28,700	5,451	4,212	2,188	3,188	500	500	27,739	36,600
Total	54,255	68,785	18,421	19,269	17,517	22,020	5,857	5,857	96,050	115,931

The third major objective--regular and reliable atmospheric sounding on a global basis and quantitative inputs to numerical weather prediction--is also being supported by NASA in experiments on the Nimbus series and by NASA development of an advanced atmospheric sounder for the new series of operational spacecraft (TIROS N). Research and development for the third major objective are emphasized in NASA's Nimbus Program and in NOAA's program to develop sensing techniques. Nimbus 5 was successfully launched in 1972 and has successfully met all its objectives. Nimbus F, to be launched in mid 1975, includes further developments in the Nimbus series of instruments. Included in the payload are instruments to provide global vertical temperature, ozone, and water vapor profiles to heights of approximately 60 kilometers. Also included in the experiments is an instrument to determine the earth radiation budget by simultaneously measuring the incoming solar radiation and the outgoing terrestrial radiation. An advanced scanning microwave radiometer provides day and night mapping of liquid atmospheric water, sea and land ice and soil moisture. Another experiment will provide measurements of lower stratospheric winds using balloon platforms and in-situ measurements from free-floating balloons and ocean buoys to verify remote measurements in the tropics. This experiment will be a valuable contribution to the Global Atmospheric Research Program. The Nimbus program has been extended with the approval of Nimbus G for launch in 1978. This mission will provide spaceborne sensors applicable to studies of air pollution, oceanography, ozone, the ocean-atmosphere interface, and the earth and atmosphere heat budget.

The Departments of Commerce and Defense and NASA conduct a wide variety of studies on the applications of meteorological satellite data to improve environmental services--the fourth major objective. Efforts will be directed to developing new methods for using satellite data in environmental analysis and forecasting. The radiative and optical properties of atmospheric constituents are being studied to aid the design of satellite-borne sensors and the interpretation of data from them. Special attention is given to interpreting and validating new data acquired by operational and research satellites and to applying these data as inputs to numerical analysis and forecasting. At NASA, emphasis is being placed on research involving severe storms which will contribute to expanding the current state of knowledge on the identification, detection, monitoring, and forecasting of severe storms. Included in this research are preliminary studies of a geostationary satellite designed specifically for the detection and monitoring of severe storms. This satellite, known as STORMSAT, will be a 3-axis stabilized system using instruments with higher spatial and temporal resolutions than those presently available. In addition to severe storms, efforts are being undertaken to establish a research program in climate studies. This effort will focus on providing global measurements which can be used to determine elements such as global radiation budget, interactions and major feedback mechanisms of the atmosphere-ocean-ground-cryosphere system, and ozone and pollutant distribution. Attention is also

being given to improving medium-range weather forecasts, mainly by development of instruments for the TIROS N and Nimbus F satellites, and by participation in Global Atmospheric Research Program activities. A separate program concentrating on environmental quality studies is receiving increased attention.

Meteorological satellites offer a new means of meeting certain Army mesoscale support requirements on the battlefield with increased efficiency, especially by acquiring data in battlefield areas commonly denied to surface-based observations. A system for providing fallout winds using radiometric data from meteorological satellites is being developed. Polar-orbiting sun-synchronous satellite systems are operationally supplying VTPR data on an operational basis over the entire globe which may be adequate for nuclear fallout prediction requirements in the clear air above clouds. New VTPR systems will become operational in FY 1976 with some penetration of satellite-derived temperature data into tropospheric clouds. The Synchronous Meteorological Satellite now provides infrared images of local areas at frequent intervals and may fill certain Army requirements for mesoscale visibility information on the battlefield. Combination of these two satellite systems may materially improve Army battlefield capabilities in the future.

Table 24 lists agency funding for meteorological satellite research, by function, for FY 1975 and FY 1976.

Table 25.--Summary of meteorological satellite flights, 1960-71

Satellite	Purpose	Launch date	Operations ceased date
TIROS I	Research	4/01/60	6/15/60
TIROS II	Research	11/23/60	2/07/61
TIROS III	Research	7/12/61	10/30/61
TIROS IV	Research	2/08/62	6/12/62
TIROS V	Research	6/19/62	5/05/63
TIROS VI	Research	9/18/62	10/11/63
TIROS VII	Research	6/19/63	2/03/66
TIROS VIII	Research	12/21/63	1/22/66
Nimbus I	Research	8/28/64	9/23/64
TIROS IX	Research	1/22/65	2/15/67
TIROS X	Operational	7/01/65	7/31/66
ESSA 1	Operational	2/03/66	5/08/67
ESSA 2	Operational	2/28/66	10/16/70
Nimbus 2	Research	5/15/66	11/15/66
ESSA 3	Operational	10/02/66	10/19/68
ATS 1	Research	12/06/66	(1)
ESSA 4	Operational	1/26/67	6/19/67
ATS 2	Research	4/05/67	(2)
ESSA 5	Operational	4/20/67	2/20/70
ATS 3	Research	11/05/67	--
ESSA 6	Operational	11/10/67	11/04/69
ESSA 7	Operational	8/16/68	7/19/69
ESSA 8	Operational	12/15/68	--
ESSA 9	Operational	2/26/69	--
Nimbus 3	Research	4/14/69	9/25/70
ITOS 1	Operational	1/23/70	6/--/71
Nimbus 4	Research	4/08/70	(3)
NOAA 1	Operational	12/11/70	8/--/71
ITOS B	Operational	10/21/71	(4)

[1]Imagery not available.

[2]Unstable attitude; data not useful.

[3]THIR, FWS, and IRIS not operable.

[4]Failed to orbit.

Table 24.--Agency supporting research meteorological satellite program costs, by function
(Thousands of dollars)

	Satellite flight projects		Satellite instruments and experiments		Spacecraft technology and associated ground equipment		Satellite data analysis and applications		Total	
Agency	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76	FY 75	FY 76
Commerce	.....	.....	1,941	1,941	.....	.....	2,770	3,500	4,711	5,441
Defense:										
Army	.....	.....	.....	.....	.....	.....	1,265	1,295	1,265	1,295
Navy	.....	.....	270	272	200	304	493	570	963	1,146
Air Force	.....	.....	548	576	.....	.....	237	166	785	742
NASA	17,474	12,253	7,793	9,147	153	160	7,199	9,218	32,619	30,778
Total	17,474	12,253	10,552	11,936	353	464	11,964	14,749	40,343	39,402

Table 26.–Meteorological satellite flights and functions 1972-75

Satellite	Purpose [1]	Launch	Orbit [2]	Functions [3]	Remarks
NOAA 2	O	10/15/72	S/1460	Image, Sounding, Space	Deactivated
Nimbus 5	R	12/12/72	S/1110	Image, Sounding, Relay	
ITOS E	O	7/16/73	S/1460	Image, Sounding, Space	Failed to orbit.
DMSP	O	8/17/73	S/830	Image, Sounding	Low light level image.
NOAA 3	O	11/06/73	S/1510	Image, Sounding, Space	Standby
DMSP	O	3/16/74	S/830	Image, Sounding, Lightning detection	
SMS 1	R/O	5/17/74	G/35700	Image, Relay, Space	75° W.
DMSP	O	8/9/74	S/830	Sounding, Auroral, Electron count	Imagery sensors failed Nov. 74
NOAA 4	O	11/15/74	S/1460	Image, Sounding, Space	Primary
SMS 2	R/O	2/06/75	G/35700	Image, Relay, Space	115° W.
Nimbus F	R	1975	S/1110	Image, Sounding, Relay	
GOES A	O	1975	G/35700	Image, Relay, Space	Note 4
ITOS E2	O	1975	S/1460	Image, Sounding, Space	Former ITOS C Spacecraft.

[1] R--Research, O--Operational, R/O--Operational Prototype.

[2] S--Sun-synchronous, G--Geosynchronous/altitude in kilometers.

[3] Image--TV-like picture of cloud patterns or sea-surface temperature patterns.
Sounding–Vertical profile of atmospheric temperature, water vapor, ozone.
Relay--Relay and tracking of surface or balloon-borne sensors.
Space--Measurement of space radiation or solar emissions.

[4] To be stored in orbit as replacement for SMS 1 or 2.

PUBLICATIONS

The Federal Coordinator for Meteorological Services and Supporting Research has either prepared or is preparing a series of publications covering the broad spectrum of meteorological programs in the Federal Government. The following is a list of these publications and their status:

The Federal Plan for Meteorological Services and Supporting Research (Published annually)

World Weather Program Plan (Published annually)

National East Coast Winter Storms Operations Plan (Revised annually)

National Hurricane Operations Plan (Revised annually)

National Severe Local Storms Operations Plan (Revised annually)

Federal Computer Plan for Operational Forecasting and Atmospheric Modeling Research--Report of the Interagency Committee on Computers for the Atmospheric Sciences (November 1974) (Under revision)

Federal Plan for Meteorological Rocket Observations (August 1974)

Federal Plan for National Climatic Services (February 1974)

National Plan for Rocketsonde Support for Special Events (February 1974)

Federal Plans for Cooperative Backup for Severe Local Storms and Aviation Winds Forecast (January 1974)

Federal Plan for Weather Radars (November 1974) (To be updated)

Comparison Test of Meteorological Measurements from Weather Reconnaissance Aircraft on May 28, 1971 (June 1973)

Federal Plan for Natural Disaster Warning and Preparedness (June 1973) (Under revision)

Federal Plan for a National Agricultural Weather Service (January 1971) (Under revision)

Federal Plan for Air Pollution Control Meteorological Service (January 1971) (Under revision)

Federal Plan for Cooperative Backup Among Operational Processing Centers (August 1970) (Under revision)

Report on Hurricane Weather Reconnaissance (September 1969)

Federal Plan for a National Fire-Weather Service (March 1967) (Under revision)

Out of Print

Federal Plan for Meteorological Data from Satellites (May 1971)

Federal Plan for Clear Air Turbulence (November 1969)

Catalog of U.S. Government Meteorological Research and Test Facilities (September 1969)

The Joint Selection Panel Report on the ESSA/USAF Joint-Use Computer Facility at Asheville, N.C. (January 1969)

Planning Guidelines for a Federal Aviation Meteorological Service (August 1968)

Federal Plan for Marine Meteorological Services (May 1968)

Implementation Plan for the ESSA/USAF Joint-Use Computer Facility at Asheville, N.C. (May 1967)

Mesometeorological Research and Development Prospectus (March 1967)

Report of the National Committee for Clear Air-Turbulence (December 1966)

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